

Developing deeper self-directed learning in Computer Applications Technology education

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DECLARATION

DECLARATION / VERKLARING

I the undersigned, hereby declare that the work contained in this dissertation / thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.


Signature

9 October 2019

Date

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PREFACE AND ACKNOWLEDGEMENTS

- I dedicate this thesis to all the learners and students that were in my classes – I have learnt so much from you.
- I firstly want to thank our heavenly Father for granting me the opportunity to do this thesis. All glory goes to Him who grants us knowledge and wisdom.

The fear of the LORD is the beginning of knowledge: but fools despise wisdom and instruction. (Proverbs 1:7, KJV)

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ABSTRACT

DEVELOPING DEEPER SELF-DIRECTED LEARNING IN COMPUTER APPLICATIONS TECHNOLOGY EDUCATION

Research indicates that self-directed learning should be fostered in education to prepare students for a changing world. Industry claims that graduates lack competencies such as critical thinking, collaboration, creativity and problem-solving, when entering the 21st-century workforce. Transfer of knowledge from a known situation to unknown situations, has been mentioned as a growing requirement for the 21st century, and the concept of deeper learning is thus gaining momentum. A literature review was conducted to obtain an understanding of self-directed learning, as well as deeper learning. The review indicated that self-directed learning remains an important factor in preparing learners for the 21st century, but the competency to transfer knowledge from a known situation to a new situation continues to be lacking. The focus has been on putting the *self* in learning, and less focus has been placed on *learning*. It is therefore suggested that *deeper self-directed learning* must be developed among students in order to foster knowledge transfer.

The aim of this thesis was to determine how deeper self-directed learning can be developed in a database module in Computer Applications Technology education. From the literature, a rationale for DL and SDL was provided to define deeper self-directed learning and to propose a theoretical basis for deeper self-directed learning. Deeper self-directed learning was defined as an infinite process that fosters lifelong learning and promotes transfer of knowledge, with the outcome of taking responsibility for own learning, to obtain transferable competencies. Cognitive load theory and social constructivist theory were identified as suitable theories to provide a foundation for deeper self-directed learning. Cooperative learning and cooperative pair programming were then proposed as teaching-learning strategies to develop deeper self-directed learning. Guidelines integrating cooperative learning, cognitive load theory, social constructivist theory and strategies to promote transfer, were suggested for instructional practices to develop deeper self-directed learning.

Design research was used as the research methodology, incorporating an embedded mixed methods design that included convergent and explanatory sequential mixed methods approaches. The research was done over a period of four years. The population of participants was two consecutive years of third-year Computer Applications Technology education students at a South African university enrolled for a database and networking module. One-on-one interviews and focus group interviews were used as qualitative data collection methods. The Self-Rating Scale of Self-Directed Learning (SRSSDL) (Williamson, 2007) and the Transferable

Learning Orientations (TLO) tool (Simper *et al.*, 2016) were used as quantitative data collection instruments to determine participants' perceived level of self-directed learning and their inclination to transfer.

The effect of implementation of the suggested guidelines in the Computer Applications Technology education class on students' self-directed learning and the transfer of knowledge and competencies, were then determined. Factors that hindered or promoted transfer were also identified. The results of this study indicate that implementation of the suggested guidelines developed deeper self-directed learning in a database module in Computer Applications Technology education. Accordingly, instructional practices can be informed to develop deeper self-directed learning among students so that they can take responsibility for their learning in such a way that transfer of knowledge and competencies can occur.

Keywords:

21st-century competencies, cognitive load theory, Computer Applications Technology education, cooperative learning, cooperative pair programming, database design, deeper learning, deeper self-directed learning, knowledge transfer, self-directed learning, social constructivist theory

OPSOMMING

DIE ONTWIKKELING VAN DIEPER SELFGERIGTE LEER IN REKENAARTOEPASSINGSTEGNOLOGIE-ONDERWYS

Navorsing toon aan dat selfgerigte leer in onderwys bevorder moet word om studente vir 'n veranderende wêreld voor te berei. Die nywerheidswêreld beweer dat gegradueerdes tekortsiet aan vaardighede soos kritiese denke, samewerking, kreatiwiteit en probleemoplossing wanneer hulle die arbeidsmark van die 21ste eeu betree. Oordrag van kennis vanaf 'n bekende situasie na onbekende situasies, is as 'n toenemende vereiste vir die 21ste eeu aangedui en dus het die konsep van dieper leer momentum gekry. 'n Literatuuroorsig is gedoen om 'n begrip van selfgerigte leer en dieper leer te kry. Die oorsig het aangetoon dat selfgerigte leer steeds 'n belangrike faktor is om leerders vir die 21ste eeu voor te berei, maar dat die vaardigheid om kennis van 'n bekende situasie na 'n nuwe situasie oor te dra, steeds tekortsiet. Die fokus was om die *self* in leer te plaas, en daar is in 'n mindere mate op *leer* gefokus. Daar word dus voorgestel dat dieper selfgerigte leer by studente ontwikkel moet word om die oordrag van kennis te bevorder.

Die doel van die tesis was om te bepaal hoe dieper selfgerigte leer in 'n databasis module in Rekenaartoeëpassingstegnologie-onderwys ontwikkel kan word. 'n Rasionaal vir dieper leer en selfgerigte leer is vanuit die literatuur verskaf om dieper selfgerigte leer te definieer en om 'n teoretiese basis vir dieper selfgerigte leer te verskaf. Dieper selfgerigte leer is gedefinieer as 'n oneindigende proses wat lewenslange leer aanmoedig en wat oordrag van kennis bevorder, met die uitkoms om verantwoordelikheid van eie leer te neem om oordrag van vaardighede te bekom. Kognitiewe ladingsteorie en sosiaal-konstruktivistiese teorie is as gepaste teorieë geïdentifiseer om 'n teoretiese basis vir dieper selfgerigte leer te verskaf. Koöperatiewe leer en koöperatiewe paarprogrammering is daarna voorgestel as onderrig-leerstrategieë om dieper selfgerigte leer te ontwikkel. Riglyne wat koöperatiewe leer, kognitiewe ladingsteorie, sosiaal-konstruktivistiese teorie en strategieë om kennis-oordrag te bevorder inkorporeer, is vir onderrig praktyke voorgestel om dieper selfgerigte leer te bevorder.

Ontwerpgebaseerde navorsing, met 'n ingebedeë gemengde-metode navorsingsontwerp wat konvergente en verklarende sekwenșiële benaderings inkorporeer, is as navorsingsmetodologie gebruik. Die navorsing is oor 'n tydperk van vier jaar gedoen. Die bevolking was twee opeenvolgende jare se derdejaar Rekenaartoeëpassingstegnologie-onderwys studente van 'n Suid-Afrikaanse universiteit, wat vir 'n databasis- en netwerkmodule ingeskryf was. Een-tot-een onderhoude en fokusgroep onderhoude is as kwalitatiewe data-insamelingsmetodes gebruik.

Die Selfassesseringskaal vir Selfgerigte Leer (*Self-Rating Scale of Self-Directed Learning* [SRSSDL]) (Williamson, 2007) en die Ingesteldheid tot Oordrag van Leer instrument (*Transferable Learning Orientations* [TLO] tool) (Simper *et al.*, 2016) is as kwantitatiewe data-insamelingsinstrumente gebruik om deelnemers se waarneembare vlak van selfgerigte leer en hul ingesteldheid tot oordrag van leer te bepaal.

Die effek van die implementering van die voorgestelde riglyne in die Rekenaartoepassingstegnologie-onderwys klas op studente se selfgerigte leer en die oordrag van kennis en vaardighede is vervolgens bepaal. Faktore wat kennisoordrag verhinder of bevorder het, is ook geïdentifiseer. Die resultate van die studie toon dat die implementering van die voorgestelde riglyne dieper selfgerigte leer in 'n databasis module in Rekenaartoepassingstegnologie-onderwys ontwikkel het. Onderrigpraktyke kan in ooreenstemming hiermee ingelig word om dieper selfgerigte leer by studente te ontwikkel, sodat hulle verantwoordelikheid van eie leer op so 'n wyse kan neem dat oordrag van kennis en vaardighede bevorder word.

Sleutelwoorde:

21ste-eeuse vaardighede, databasisontwerp, dieper leer, kognitiewe ladingsteorie, koöperatiewe leer, koöperatiewe paarprogrammering, dieper selfgerigte leer, kennisoordrag, Rekenaartoepassingstegnologie-onderwys selfgerigte leer, sosiaal-konstruktivistiese teorie

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CHAPTER 1:

INTRODUCTION

1.1 BACKGROUND TO THE PROBLEM STATEMENT, AND THE MOTIVATION FOR THE STUDY

According to Nixon (2011:1) and the National Research Council (NRC) (2012:1), higher education is linked to the public good, as it contributes to society, the workforce, and personal circumstances. Higher education students have to be prepared for an uncertain future (Klappa, 2015:12; Knowles, 1975:15; North-West University [NWU], 2017:4; Robinson, 2006). Students face challenges in their academic careers and work environments and other areas of adult responsibilities, and they thus need certain 21st-century skills and competencies (Ananiadou & Claro, 2009:7; Klappa, 2015:12; Ng, 2015:317; NRC, 2012:2; NWU, 2017:5). Examples of such skills and competencies are critical thinking, creativity, problem-solving, communication, and collaboration (Klappa, 2015:12; Ng, 2015:317; NRC, 2012:1; NWU, 2017:2; Partnership for 21st Century Learning, 2019:2). According to the Partnership for 21st Century Learning (2019:3), the above-mentioned skills and competencies, among others, determine readiness for working in 21st-century environments. The Society for Human and Resource Management (SHRM) of the USA, state that a global shortage of skills exists and the skills shortage is deteriorating (SHRM, 2019:3). Industry thus still claims that new graduates lack appropriate skills and fall short in areas such as collaboration, critical thinking, and communication (Fisher, 2016; Hurrell, 2016:607; Taylor, 2016:16).

The NRC in the United States of America launched a study to obtain insight into necessary skills and competencies and the development thereof, in order to prepare learners for the challenges of the 21st century. From this study, the development of transferable knowledge in order to adapt to changing situations was identified as important for success in the 21st century (NRC, 2012:70). The NRC concluded that deeper learning (DL) is the process of developing transferable knowledge and skills, called “competencies”, and that the product of DL is transferable knowledge (NRC, 2012:8, 23).

In recent years, a growing movement to foster self-directed learning (SDL) among students and learners globally has gained momentum. Self-directed learners take responsibility for their own learning and should have the ability to be lifelong learners (Knowles, 1975:16). In this thesis, it will be argued that the focus of SDL research has been on putting the self in learning – by determining characteristics and skills to define SDL (Ayyildiz & Tarhan, 2015; Williamson, 2007), fostering these skills and characteristics, and determining learners’ SDL readiness (Guglielmino, 1978). Less emphasis has been placed on the *learning* in SDL.

In order for learners to become lifelong learners in the 21st century, it is thus argued that they need to connect what they are learning in class to life outside of class (Kuh, 2016:55), and to apply what they have learnt in one subject area to newly encountered situations in other contexts (Martinez *et al.*, 2016:4). We thus need students who engage in deeper self-directed learning (DSDL) and who can take responsibility for their own learning (SDL), in such a way that transfer of knowledge and skills can take place (DL) from one situation to another (see section 3.4.3).

In South Africa, Computer Applications Technology (CAT) education students take database design and networking as a subject module in their teacher training. Experience has shown that students find this module difficult, as they need to be able to design, implement and maintain databases for real-life situations. They also need to apply theoretical concepts about computer networks to real-life situations. As student teachers with the prospect of becoming teachers, they are required to be lifelong learners, to be able to facilitate learning when teaching relevant subject content and competencies. As CAT teachers, they will most probably have a senior responsibility in maintaining the school's database and computer networks, as well as applying their knowledge to several other real-world scenarios. They thus need to be self-directed learners and have deep subject knowledge, and they should be able to transfer their knowledge to various real-life situations. Although the module included a networking component, the research focused on the database component of the module. The following research question was therefore addressed in this study:

How can DSDL be developed in a database module in CAT education?

The following section explains the conceptual and theoretical framework that was developed as the basis for this research.

1.2 CONCEPTUAL AND THEORETICAL FRAMEWORK

To elaborate on the conceptual and theoretical framework for this research, a discussion of the concepts of 21st-century skills, DL (see section 2.2) and SDL (see section 3.2) and the subject of CAT will follow. Thereafter a short discussion will follow on cognitive load theory (CLT) (see section 1.2.4) and social constructivist theory (SCT) (see section 1.2.5), which were proposed as a theoretical framework for DSDL in this study.

1.2.1 Twenty-first-century skills and competencies

In order to provide a definition of DL, the concepts of competencies and skills first need to be clarified, as these concepts are often mentioned with regard to DL and SDL. Although the terms “competencies” and “skills” are often used interchangeably (Beckett, 2018), they have specific meanings related to the context in which they are used.

1.2.1.1 Defining skills and competencies

According to Allais (2012:633), the notion of what a skill is, is highly contested. Beckett (2018) defines skills as specific learnt activities that vary in complexity, referring to the type of abilities that individuals need to perform certain tasks. Some authors refer to “soft skills” (Fisher, 2016; Hurrell, 2016; Taylor, 2016), defined as intra- and interpersonal skills, which are “essential for personal development” and “social participation”, in specific environments (Taylor, 2016:3). Examples of such skills are critical thinking and communication (Hurrell, 2016:606; Taylor, 2016:16). According to Balwanz and Ngcwangu (2016:48), the existing literature defines five broad categories of skills, namely basic, cognitive, non-cognitive, life and technical skills.

A competence can be seen as a broader concept than a skill (Ananiadou & Claro 2009:8; Beckett, 2018; Rychen & Salganik, 2005:4). The NRC (2012:3) uses the term “competence” to refer to a combination of knowledge and skills. According to Rychen and Salganik (2005:4), a competence should be seen as “the ability to successfully meet complex demands” in a specific context. A competence is further described as having internal structure, namely knowledge, skills, and attitudes. The “ability to communicate effectively” is seen as a competence (Rychen & Salganik, 2005:4), drawing on language knowledge, communication skills, and attitudes towards the person with whom communication is taking place (Rychen & Salganik, 2005:4).

Although skills and competencies can be viewed differently, they can also be viewed as similar concepts. For example, collaboration is referred to as a skill (NRC, 2012:219) or a competence (Huberman *et al.*, 2014:2). Accordingly, Puig *et al.* (2019:860) refer to critical thinking as a competence, but Guglielmino *et al.* (1987:315) refer to critical thinking as a skill. According to Oxford University Press (2016), a skill is the ability to do something well, or in an expert way, and a competence is the ability to do something successfully or efficiently. In light of these two definitions, there is not much difference between skills and competencies. Therefore, because no clear distinction between the concepts of skills and competencies could be found in the literature, the terms “skills” and “competencies” will be used interchangeably in this study in the interpretations of various authors.

1.2.1.2 Skills and competencies needed in the 21st century

Researchers have different opinions on 21st-century skills (21CS). According to Ananiadou and Claro (2009:8), 21CS can be defined as skills required to be “effective workers and citizens in the knowledge society of the 21st century”. The NRC (2012:16) views 21CS as “knowledge that can be transferred or applied in new situations”, and thus as “transferable knowledge”. This knowledge, however, includes both content knowledge and the knowledge of how, why and when to apply this knowledge (NRC, 2012:23). The Partnership for 21st Century Learning

(2019:2) defines 21CS as the ability to possess a combination of content knowledge, specific skills, expertise, and literacy, which are needed to succeed in work and life.

According to the different opinions, different frameworks for 21CS have been developed (Ananiadou & Claro, 2009:8; NRC, 2012:23–24; Partnership for 21st Century Learning, 2019:3–8; Taylor, 2016:13; Wilson, 2015). The ranking of required skills by industry also differs at different times. According to Chun (2013), in the 1970s, writing and computational thinking were the most sought-after competencies on the Forbes 500 list, with interpersonal competencies and problem-solving ranking below number ten on the list. In the 1990s, the latter competencies rose to occupy the top three positions. In 2012, the most sought-after 21CS in the industry were problem-solving, collaboration, and critical thinking, with technology and social media skills being the least sought-after 21CS (Fisher, 2016). According to the SHRM (2019:4), the top missing skills among job seekers in 2018 were problem-solving, critical thinking, innovation and creativity, the ability to deal with complexity and ambiguity, and communication skills.

The NRC (2012:32–35) has proposed a taxonomy of 21st-century competencies, grouped into three domains of competence, namely cognitive, interpersonal and intrapersonal competencies (see Table 1.1). Some competencies within these domains are listed in Table 1.1. In section 2.2.2.2 the three domains of competence will be elaborated on.

Table 1.1: Clusters of 21st-century competencies (NRC, 2012)

Cognitive	Intrapersonal	Interpersonal
Critical thinking	Flexibility	Communication
Problem-solving	Adaptability	Collaboration
Reasoning, argumentation	Social responsibility	Teamwork
Adaptive learning	Continuous learning	Cooperation
Creativity	Self-direction	Interpersonal skills
	Self-regulation	Negotiation

In the discussion above, a framework for 21CS was provided. This discussion will now be elaborated on, in order to define DL.

1.2.2 Deeper learning

Deeper learning can be regarded as an evolving concept (Huberman *et al.*, 2014:1). In 2012, the Committee on Defining Deeper Learning and 21st Century Skills did an extensive study to define DL (NRC, 2012). In that study, DL was defined as “the process through which an individual becomes capable of taking what was learned in one situation and applying it to new situations (i.e., transfer)” (NRC, 2012:5).

According to the above definition, DL is seen as a process, and the product of DL should be regarded as transferable knowledge. DL is further described as a twofold process that occurs within the individual's mind and through social interactions within a learning community, resulting in transfer of knowledge (NRC, 2012:74). Nelson Laird *et al.* (2014:404) define DL as learning that is marked by growth in areas such as critical thinking, a need to acquire knowledge, and positive attitudes towards literacy. The latter definition mentions various skills, but transfer of knowledge is absent from the definition, and this is regarded as the essence of DL (NRC, 2012:8).

According to Goldstone and Day (2012:149), understanding how knowledge is transferred to new situations is of both theoretical and practical importance, as learning without being able to transfer what has been learnt is mostly unproductive and inefficient. Transfer can be viewed from different paradigms (Lobato, 2008:170). Transfer of knowledge is classically viewed as the application of knowledge that has been learnt in one situation to another situation (Belenky & Nokes-Malach, 2012:400). Research has, however, shown that getting students to transfer what they have learnt to new situations is quite difficult (Goldstone & Day, 2012:149). Recently, new theoretical positions have emerged on whether and how transfer of knowledge can be achieved (Goldstone & Day, 2012:149). One perspective is that transfer involves the adoption of new perspectives (Goldstone & Day, 2012:149), where new ways of seeing familiar situations are developed (Chi & VanLehn, 2012:187; Lobato *et al.*, 2012:476). Another perspective is that even in seemingly unsuccessful transfer, students could have attempted transfer (Belenky & Nokes-Malach, 2012:399; Lobato, 2003:18). These new perspectives open up new possibilities and encourage further research into transfer of knowledge. Perspectives on transfer were discussed in more detail in section 2.2.3.1.

To produce transferable knowledge (Chun, 2013; Huberman *et al.*, 2014:1; Nelson Laird *et al.*, 2014:404), and thus be a deeper learner, knowledge and skills are intertwined in the process of DL. This deeper cognitive process of DL develops 21st-century competencies, which can be used in new situations, and which, in turn, support the process of DL “in a recursive, mutually reinforcing cycle” (NRC, 2012:99).

As the terms “DL” and “deep approaches to learning” are sometimes used interchangeably (Gordon & Debus, 2002; Nelson Laird *et al.*, 2014), it is necessary to clarify the concepts of deep learning and deep approaches to learning. Deep learning is defined by Gordon and Debus (2002:484) as learning where meaningful, context-based learning has taken place, with consequent development of analytical, problem-solving skills. A deep approach to learning results from a student's need to engage appropriately and meaningfully in a task (Biggs & Tang, 2011:88). When students follow a deep approach to learning, their intention for learning is to

understand the deeper meaning and the way concepts relate to and connect with each other (Gordon & Debus, 2002:484; Mathieson, 2015:107). According to Nelson Laird *et al.* (2014:405), research also links deep approaches to learning to transfer of information. Thus, deep approaches to learning can also support DL.

It may thus be concluded that DL is the process of transferring knowledge and skills to new situations, and thus to solve new problems by transferring what has been learnt. A more detailed discussion of DL can be found in section 2.2.

1.2.3 Self-directed learning

Self-directedness is increasingly mentioned with regard to various contexts and competencies (Bellanca, 2015:6; NRC, 2012:24; Partnership for 21st Century Learning, 2019:6; Trilling & Fadel, 2009:79). According to Wilson (2015), “a deep hunger to learn and grow and a willingness to experiment in order to learn” is regarded as a crucial competence by employers. The NRC (2012:24) claims that the personality trait of conscientiousness may also be called “self-direction”. The term “SDL”, however, is used to describe self-direction with regard to learning as discussed in this section.

The process of SDL has deep theoretical roots and has been widely researched (Ayyildiz & Tarhan, 2015; Bolhuis, 2003; Guglielmino, 1978; Knowles, 1975; Long, 2000). Self-directed learning was inspired by the developments in a rapidly changing world, the consequent responsibility of individuals to take initiative for their own learning, and the fact that most individuals know how to be taught but not how to learn (Knowles, 1975:14–15). According to Knowles (1975:18), SDL is defined as

a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing strategies and evaluating learning outcomes.

According to Long (2000:16), SDL as defined by Knowles (1975) addresses the external manifestations of SDL, focusing on how to become self-directed in learning. Long (2000:11) adds a psychological conceptualisation to SDL and states that certain internal processes should be present in individuals for them to be authentic self-directed learners. These processes are metacognition, motivation, and self-regulation, and they have various sub-processes, namely self-reinforcement, self-monitoring, self-instruction, self-efficacy, and self-evaluation (Long, 2000:16).

While SDL is important for learning in the 21st century, fostering SDL among learners is a complex and challenging process (Francom, 2010:38). Several characteristics and skills need to

be addressed (Ayyildiz & Tarhan, 2015:1). According to Guglielmino (2008:2), the personal characteristics of the learner, including their attitudes, values and abilities, will determine whether SDL will take place. Characteristics such as persistence, self-discipline, a high degree of curiosity, and goal orientation (Guglielmino, 1978) and skills such as collaboration, problem-solving, creativity, and critical thinking (Bolhuis, 2003; Guglielmino *et al.*, 1987:315; Williamson, 2007) have all been identified as necessary for SDL. Educators therefore have the challenging task of attending to personal characteristics (Guglielmino, 2008:2), psychological aspects of learning, and various other skills (Bolhuis, 2003:329, 343) when fostering SDL. Self-directed learning was discussed in more detail in section 3.2.

The skills required for SDL and DL overlap. According to the NRC (2012:99), skills in the cognitive, intrapersonal and interpersonal domains play an important role in DL and the consequent development of transferable knowledge. Huberman *et al.* (2014:2) mapped skills conducive to DL within the domains identified by the NRC (2012:99). In the above discussion, it has been shown that the process of SDL is also deeply rooted in these skills. Table 1.2 shows the overlap between skills identified with regard to DL and SDL. It should be noted that Table 1.2 only includes some skills and characteristics mentioned with regard to SDL, in order to show the similarities with DL. A more detailed discussion of characteristics and skills was done in section 3.4.1, and was summarised in Table 3.1.

Table 1.2: Comparison of some skills required for DL and SDL

Domains of competence	Competencies of DL (Huberman <i>et al.</i> , 2014:2)	Characteristics of and skills required for SDL (Ayyildiz & Tarhan, 2015)
Cognitive domain	Deep content knowledge	
	Problem-solving	Problem-solving
	Critical thinking	Critical thinking
		Creativity
Intrapersonal domain	Learning-to-learn competencies	Metacognitive skills
	Academic mindsets	Self-discipline
		Goal orientation
Interpersonal domain	Collaboration	Collaboration
	Communication	Communication

Although it seems that commonalities can be found with regard to 21CS when discussing SDL and DL, these two processes have at least one difference, namely transfer of learning. While DL

occurs when learners can transfer what has been learnt to new situations, SDL occurs when learners take responsibility for their own learning. For learners to become lifelong learners, they therefore need to be able to take responsibility for their own learning but also be able to transfer what has been learnt to new situations – thus be deeper self-directed learners.

The call for further research in DL regarding the design of instructional practices that not only increase transfer in the cognitive domain but also target the development of other cognitive, intrapersonal and interpersonal competencies (NRC, 2012:8–11) provided the basis for this study. By developing the concept of DSDL, the aim was to motivate that neither DL nor SDL on their own are sufficient for developing 21st-century competencies for lifelong learning, and that there is thus a need to integrate the processes of DL and SDL for instructional practices to develop learners' DSDL.

In order to provide a theoretical grounding for DSDL to answer the above research question, cognitive load theory (CLT) and social constructivist theory (SCT) will now be discussed. A more detailed discussion of CLT and SCT was done in sections 2.3.1 and 2.3.2 respectively.

1.2.4 Cognitive load theory

Cognitive load theory (Sweller, 1988) describes cognitive processing during learning. According to Paas *et al.* (2010:116), CLT has become an influential theory regarding instructional design, especially where the learning of complex cognitive tasks (as is often found in database design) is concerned. Complex tasks can be described as tasks where a large number of elements have to be processed simultaneously (Paas *et al.*, 2010:116). Learning that involves complex tasks can thus be described as demanding, and hence it requires a high level of cognitive processing.

CLT can be explained by referring to two types of memory in the human mind, namely long-term memory (LTM) and working memory (WM). A person's LTM is said to have virtually unlimited capacity (Sweller *et al.*, 2011:19), and it plays a considerable role in problem-solving and thinking (Sweller *et al.*, 2011:22). Unlike the LTM, the WM is limited in duration and capacity (Paas *et al.*, 2010:117). New content should therefore constantly be rehearsed to be held in the WM indefinitely, as this will assist in transferring information to the LTM (Sweller *et al.*, 2011:43). The limitations of the WM, however, only apply to new information. As soon as content in the WM has been integrated with existing schemas in the LTM, new knowledge is stored as new schemas in the LTM, which can again be integrated with new content in the WM (Paas *et al.*, 2010:117; Sweller *et al.*, 2011:44).

During processing of instructional information and learning, the available resources in the WM will be allocated to two main types of cognitive load, namely intrinsic cognitive load and extraneous cognitive load (Choi *et al.*, 2014:227; Paas *et al.*, 2010; Sweller *et al.*, 2011).

Intrinsic cognitive load is determined by the difficulty of the content (Sweller *et al.*, 2011:57), the consequent complexity of tasks, and the expertise of the learner (Van Merriënboer *et al.*, 2006:343). Thus, the more difficult the content, the greater intrinsic cognitive load is imposed on the WM. Extraneous cognitive load is imposed by the way in which information is presented, and by the activities that students are required to engage in (Sweller *et al.*, 2011). Poorly designed instruction will typically impose a great extraneous cognitive load on the WM (Van Merriënboer *et al.*, 2006:343).

Research has shown that improving and managing WM resources can enhance transfer of learning (Paas & Van Gog, 2006; Van Merriënboer *et al.*, 2006; Waris *et al.*, 2015:1). Thus, when designing instruction according to the CLT, the aim will be to balance the cognitive loads, in order to provide more resources to the WM. This also entails acquiring a large knowledge base in the LTM (Paas *et al.*, 2010:116).

1.2.5 Social constructivist theory

The basis of SCT, as stated by Thomas *et al.* (2014:2), is that learning occurs through social interaction. According to Vygotsky (1978:86), all people have a zone of proximal development, defined as “the distance between the actual development level [that which a person can do or know at that stage] and the level of potential development”, which can be obtained in collaboration with more capable peers. Students are thus said to have more potential capabilities, and strategies should therefore be implemented to nurture these potential capabilities by collaborating with peers.

When students are actively engaging and exchanging ideas in groups, they are exposed to various perspectives on problems and solutions to problems, which can promote their understanding of concepts (Murphy *et al.*, 2005:342; Stearns, 2017:72). Transfer of knowledge can hence be developed within such an environment of multiple perspectives (Stearns, 2017:72).

In the following section, the subject of CAT will be discussed, in order to explain the context within which DSDL will be developed in this study.

1.2.6 Computer Applications Technology

Student teachers at South African universities specialise in specific subject disciplines to provide a knowledge base for teaching related school subjects. CAT is an elective subject that can be studied by high school learners in grades 10 to 12 in South Africa. In the Curriculum and Assessment Policy Statement (CAPS) of the Department of Education, CAT is defined as “the study of the integrated components of a computer system (hardware and software) and the practical techniques for their efficient use and application to solve everyday problems” (DBE,

2011:8). The curriculum content of CAT is built on six overarching topics, which include “solution development” and “network technologies”. Database design is one of the subtopics of solution development.

CAT education students at a specific South African university, have to enrol for a database and networking module in the second semester of their third year of study. The purpose of the module is to equip students with knowledge about the design, implementation and maintenance of databases, and with knowledge about computer networks, in preparation for their prospective role as CAT teachers. This research will focus on the database component of the module. A sound knowledge of database software such as Microsoft Access is also required. At a higher level, students should be able to apply their database knowledge – firstly as future teachers to facilitate teaching and learning in the subject of CAT, but also to deal with real-life problems.

CAT teachers are also often regarded as information and communication technology (ICT) specialists at their schools. Schools have their own unique ICT needs, especially regarding database applications. Examples of database applications are school administration and management systems that manage data of learners, parents, finances, athletics meetings, and other miscellaneous applications, such as fundraisers. Most schools cannot afford to employ ICT specialists. The CAT teacher is often required to support staff members in operating the administration and management system, to provide expertise for software and hardware solutions, or to develop solutions for miscellaneous applications.

From the above discussion, it should be clear that prospective CAT teachers not only need to acquire sound content knowledge of databases and networks and current knowledge of hardware and software, but also need to know how to apply such knowledge in a variety of practice-related scenarios. Other competencies, such as interpersonal and problem-solving skills, are also required. As stated by Breed (2013b:14), CAT teachers should have adequate professional competencies and a disposition to lifelong learning.

Thus, to address the required competencies for CAT education students who need to live and work in the 21st-century, the research question of this study is the following:

How can DSDL be developed in a database module in CAT education?

1.3 AIMS AND OBJECTIVES OF THE STUDY

In order to answer the above research question, the following research sub-questions will be used as guidelines:

1. How can DSDL be defined theoretically?
2. What guidelines regarding instructional practices can be suggested to develop DSDL?

3. How can the suggested guidelines be implemented in the CAT education class at university?
4. What are the implications of implementing the suggested guidelines in the CAT education class at university?
 - a. What are students' experiences of implementation of these guidelines?
 - b. What is the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills?
 - c. What factors hinder or promote transfer?
 - d. What is the effect of deliberate implementation of the suggested guidelines on students' SDL?

The twofold aim of the study was thus to determine how DSDL can be developed among CAT education students in a database module and to determine the implications of deliberate implementation of the suggested guidelines on developing DSDL. To realise this aim, the following objectives were formulated:

1. To define the term "DSDL" (see Chapters 2, 3 and 6).
2. To suggest guidelines regarding instructional practices to develop DSDL (see Chapters 3 and 6).
3. To determine how the suggested guidelines can be implemented in the CAT education class at university (see Chapters 4, 5 and 6).
4. To determine the implications of implementing the suggested guidelines in the CAT education class at university (see Chapters 4, 5 and 6).
 - a. To determine students' experiences of implementation of the suggested guidelines.
 - b. To determine the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills.
 - c. To determine the factors that hindered or promoted transfer.
 - d. To determine the effect of deliberate implementation of the suggested guidelines on students' SDL.

In section 1.4, the research design applied in this study will be discussed, with reference to the methodology employed in the study, the population, data collection, data analysis, the reliability and validity of the research, and ethical issues. An elaborate discussion of the research design was done in Chapter 4.

1.4 RESEARCH DESIGN

The aim of this research (see section 1.3) required multiple research methods in order to build the theory of DSDL, to suggest guidelines for instructional practices to develop DSDL, and to determine the implications of deliberate implementation of the guidelines. The research was

done from a pragmatic paradigm. Design research methodology with an embedded combined convergent and explanatory sequential mixed methods research, (Creswell, 2014:227), was applied.

As stated by Creswell (2014:228) regarding an embedded mixed methods design, qualitative data were collected after each intervention (see section 1.4.3.1 and Figure 4.5) to determine participants' experiences of the interventions. The design was convergent, because open-ended questions were collected with the TLO-questionnaire (see sections 1.4.5.1 and 4.4.1.2.2) and analysed separately from the quantitative data (Creswell, 2014:219). The findings of quantitative and qualitative data were then compared (see sections 4.4.3.2, and 6.3) to address the research questions. The design was explanatory and sequential, as data from the transfer tests (see sections 1.4.5.3 and 4.4.1.1) were collected to inform the selection of participants for interviews that followed after the transfer tests (Creswell, 2014:224) (see Figures 1.2 and 4.5). Quantitative and qualitative data had more or less equal emphasis with respect to addressing the research questions. Only when interpreting the results to adjust the intervention (see sections 5.1.1.4, 5.1.5, and 5.2.1.4) and finally disseminate the research (see Chapter 6) were the quantitative and the qualitative results integrated. A detailed discussion of the embedded mixed methods research design, was done in section 4.2.3.

1.4.1 The pragmatic paradigm

According to Teddlie and Tashakkori (2003:21), the following, among others, can be noted regarding pragmatism:

- both quantitative and qualitative research methods can be used in the same research study and within multistage research;
- the research question is seen as more important than the methods used; and
- the research philosophy can be described as “practical and applied” (Teddlie & Tashakkori, 2003:21).

All of the above applied to the research design to determine how DSDL can be developed. The research was guided by multiple research questions (see section 1.3). Both quantitative and qualitative research methods were used, so as to provide rich data for answering the research questions (Hesse-Biber, 2010:3). Multistage research applied, as several interventions were applied and various phases of data collection occurred (see Figure 1.2). Furthermore, according to Coe (2012:8), pragmatic paradigm research may be conducted for particular reasons likely to be influenced by the values and beliefs of the researcher. In this study, it was the belief of the researcher that the theory of DSDL could be contextually developed and applied, and also be

analysed for transferability to other situations, as mentioned by Shannon-Baker (2016:322) with regard to pragmatism.

1.4.2 Design research as the methodology

Collins *et al.* (2004:19) recommend design research as the methodology when one has the dual goal of refining theory and practice. Researchers agree that design research addresses various issues central to the study of learning (Collins *et al.*, 2004:16; McKenney & Reeves, 2012:63). Examples of such issues are theoretical questions about the nature of learning in context, studying learning phenomena in the real world, and going beyond narrow measures of learning (Collins *et al.*, 2004:16). All these examples apply to DSDL. The first aim of this research was to define DSDL, addressing a theoretical question about the nature of learning. The learning phenomenon of DSDL was studied in a real-life application, namely the CAT education class. DSDL furthermore has a DL (see section 1.2.2) component, and it was therefore regarded as going beyond narrow measures of learning.

In order to determine the form and the function of a design, the epistemological basis on which the design is built should be determined (Middleton *et al.*, 2008:35). Collins *et al.* (2004:19) suggest that qualitative and quantitative measures should be applied to ensure careful observation of the design. In this study, quantitative and qualitative data collection methods (see section 1.4.5) were carefully selected to provide ample results, to ultimately address the various research aims and objectives (see section 1.3).

Design research is also mentioned where transfer of learning is researched (Lobato, 2008:190; McKenney & Reeves, 2012:105). Lobato (2008:190) proposes a multistage model of design research. In such a model, an intervention is applied, and the effect of the intervention is determined. According to the results obtained, the intervention is then adjusted and is applied again, after which new results are obtained. Lobato (2003:18) refers to repetitive applications of interventions and subsequent evaluation thereof as iterative cycles.

According to Middleton *et al.* (2008:32–41), the complete design research cycle typically consists of seven phases (see Figure 4.1). The first phase establishes the research problem or pedagogical issue that needs to be addressed by an intervention. In phase 2, some predetermined criteria or guidelines should be determined. In the third phase, the feasibility of the study, especially with regard to a time frame and expenses, is determined. Phases 4 and 5 are characterised by iterative processes. Phase 4 entails prototyping and the development of an initial intervention model. According to Middleton *et al.* (2008:32–41), phase 4 is typically characterised by piloting small-scale prototypes of the intervention. In phase 5, the intervention is tested and modified, by implementing the intervention on a larger scale. Results have to be disseminated at some stage, and phase 6 therefore consists of a definitive test, which is then

disseminated in phase 7. Finally, in phase 7, findings are made available to the teaching and learning community.

It is questionable whether design research is suitable for short-term projects, as was the case in this study. Pool and Laubscher (2016:9), however, argue that the main outcomes of design research can still be achieved with short-term projects in education, although an exhaustive number of cycles cannot be implemented. McKenney and Reeves (2012:77) (see Figure 4.3) accordingly propose a generic model, which incorporates the essential elements to conduct design research in education.

According to McKenney and Reeves (2012:77), design research in education has three core phases. In this study, these three phases are indicated as phases A, B and C (see Figure 4.3). The three phases are analysis and exploration (phase A), design and construction (phase B), and evaluation and reflection (phase C). Each phase contributes to the practical maturing intervention and to the theoretical understanding of the problem. In phase A, the problem is defined and goals are developed. In phase B, a tentative solution to the problem is developed and the solution is prototyped. In phase C, empirical testing of an intervention is done and conclusions are formed.

McKenney and Reeves (2012:78) further distinguish between micro-, meso- and macro-cycles in their design research model. Each phase as described above consists of its own cycle of action, called a micro-cycle. When two or more micro-cycles are combined, a meso-cycle is formed. The entire research design process, which usually includes combinations of micro- and meso-cycles, is called a macro-cycle.

In section 1.4.3, the research design of this study will be aligned with the above discussion, and hence with reference to the models proposed by Middleton *et al.* (2008:32) and McKenney and Reeves (2012:77). An overview of the research design will first be given, and thereafter the methods used in a meso-cycle will be elaborated on.

1.4.3 The research design and methods

Phases A, B and C as described above were incorporated in the research design for DSDL in the following way:

- phase A – continuously reviewing the literature, to provide a deeper understanding of the problem, and building a theory for DSDL;
- phase B – developing an intervention and applying the intervention (hereafter this will be referred to as the DSDL intervention); and
- phase C – evaluating the results and reflecting on the design.

Figure 1.1 depicts the time frame for the research. In the first year, a literature review was conducted, to provide an understanding of the problem and to define DSDL, so as to provide a theoretical underpinning for DSDL. The main databases that were consulted were Google Scholar and EBSCOhost. In EBSCOhost, the databases of Academic Search Premier and ERIC were included. Hit words that were mainly used were “21st-century skills”, “21st-century competencies”, “21st-century learning”, “transfer of learning”, “transfer of knowledge”, “knowledge transfer”, “learning”, “deeper learning”, “deep learning”, “approaches to learning”, “self-directed learning”, “cooperative learning”, “cognitive load theory”, “social constructivist theory”, “cooperative learning”, “collaborative learning”, “design research”, “design research and education”, and “mixed methods research”.



Figure 1.1: Time frame for the research
(Source: own contribution)

In the second year of the study, a prototype of the intervention, as recommended by Middleton *et al.* (2008:32–41), was designed, implemented and evaluated. In year 3, the intervention was redesigned and evaluated again (Middleton *et al.*, 2008:37). Finally, in year 4, the results were evaluated, reflected on and disseminated.

To elaborate on the design of this research, Figure 1.2 outlines the phases of a meso-cycle (see section 1.4.2) as applied in this research in the second and third years of this study.

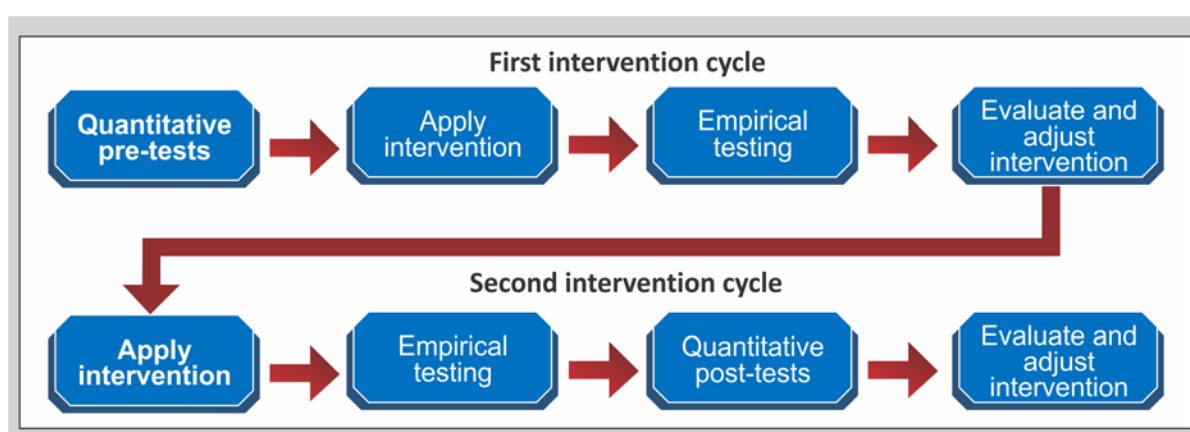


Figure 1.2: Structure of a meso-cycle
(Source: own contribution)

A meso-cycle consisted of two intervention cycles. Each intervention cycle consisted of an instructional intervention, where guidelines to develop DSDL were implemented, and empirical

testing to determine students' experiences of the intervention and the effect of the intervention on their DSDL. After evaluating an intervention, adjustments were made to the suggested guidelines according to the results of the empirical testing and in accordance with the literature. The intervention cycles will now be briefly elaborated on.

1.4.3.1 Intervention cycles

Based on the literature, guidelines were suggested to develop DSDL (research objective 2). According to these guidelines, instructional interventions (see section 4.2.2.5) were applied. As indicated in Figure 1.2 and in Figure 4.5, a meso-cycle consisted of two intervention cycles that were applied to a group of participants in a time period of 11 weeks.

At the start of the first intervention cycle, quantitative pre-tests (see sections 1.4.5.1 and 4.4.1) to determine participants' initial perceived level of SDL and their inclination to transfer were conducted. An intervention to develop DSDL (see section 4.2.2.5 and Table 4.2) was then applied for three weeks. Thereafter, an evaluation of the intervention was done by empirical testing, to determine students' experiences of the intervention (research objective 4a), the effect of the intervention on transfer (research objective 4b), and the factors that hindered or promoted transfer (research objective 4c). According to the results of the empirical testing, the intervention was adjusted to be implemented in the second intervention cycle.

In the second intervention cycle, the adjusted intervention (see Table 4.3) was implemented for three weeks (see Figure 4.5). Again, an evaluation of the intervention was done to satisfy research objectives 4a, 4b and 4c, as indicated in the above paragraph. Quantitative post-tests (see section 1.4.5.1) were conducted after applying the intervention to determine participants' perceived level of SDL and their inclination to transfer at the end of the meso-cycle. At the end of year 2 (see Figure 1.1), the intervention was again evaluated and adjusted, for implementation with a different group of participants, who were enrolled for the same module in the following year.

In section 1.4.2, a motivation for the choice of design research as the research methodology was given. In this section, the research design, the structure of a meso-cycle, and the intervention cycles were discussed. Next, the participants, the population, and the sampling procedure will be elaborated on.

1.4.4 Participants, population, and sampling

In this section, the participants, the population, and the sampling procedure are discussed. Although mention will be made of the data collection methods employed, namely questionnaires and semi-structured interviews, in order to explain the sampling procedure, these data collection methods will only be discussed in section 1.4.5.

As indicated in Figure 1.1, the empirical study was done in the second and third years of the research. The population of participants (N = 73) was two consecutive years of third-year CAT education students from a South African university enrolled for a database and networking module. According to Bartsch (2013:31), researchers who study teaching and learning are often limited to which students they can study, and getting a sample that will generalise to all students can rarely be achieved. Therefore, non-probability sampling and a convenience sampling approach (Creswell, 2015:145) was used. The sample consisted of all students who were willing to become involved in the research and who gave informed consent. These students will in the remainder of the study be referred to as participants. There were no exclusions for this research in terms of participants, except that only students enrolled for this specific module at this university could participate in the research.

Questionnaires were administered to all willing participants. When selecting participants for interviews, however, it is typical in qualitative studies to select only a few participants, due to the time involved in collecting and analysing the data (Creswell, 2008:217). Due to the small population size, and to obtain rich data, a few participants were not selected, but all willing participants were invited to interviews.

The invitations for interviews were further based on the quantitative results of the transfer tests (see section 1.4.5.3). Participants were grouped into three categories according to the results of the tests, namely “successful transfer”, “attempted transfer”, and “no transfer”. Participants were, however, not informed of these groupings. Participants that obtained between 75% and 100% for the transfer test were assigned to the successful transfer group. Participants that obtained between 50% and 74% for the transfer test were assigned to the attempted transfer group. Participants that obtained between 0% and 49% were assigned to the no transfer group. A focus group interview (see section 1.4.5.2) was conducted with all willing participants from the successful transfer group. More participants could thus be involved to share the strategies that they had successfully applied in the tests, and less time was required for interviews (Creswell, 2008:226). All participants who were assigned to the attempted transfer and the no transfer groups were invited to one-on-one interviews.

1.4.5 Data collection and analysis

The Self-Rating Scale of Self-Directed Learning (SRSSDL) (Williamson, 2007) and the Transferable Learning Orientations (TLO) tool (Simper *et al.*, 2016) were used as questionnaires for the quantitative data collection. Open-ended questions from the TLO, focus group interviews, and one-on-one interviews were used as qualitative data collection methods. Transfer tests (see section 1.4.5.3), to determine how participants transferred their knowledge,

were used as quantitative and qualitative data collection instruments. These data collection methods will be elaborated on in the discussion below.

1.4.5.1 Questionnaires

According to Creswell (2008:55), questionnaires are data collection instruments designed for measuring specific variables in research. Specific questions are thus developed in order to obtain quantifiable data from participants. Willing participants submitted their responses to questionnaires electronically via Google Forms. The SRSSDL questionnaire (Williamson, 2007) was administered to each willing participant as a pre-test at the beginning of each meso-cycle and as a post-test at the end of each meso-cycle (see Figure 1.2). Participants had to answer closed-ended questions by means of selecting response categories in the form of a five-point Likert-type scale (Johnson & Turner, 2003:304). The purpose of using the SRSSDL was to determine the effect of applying the interventions, by measuring students' SDL, in order to address research objective 4d (see section 1.3). Demographic characteristics of participants were also recorded by the SRSSDL, in order to provide a better understanding of the participants (Bartsch, 2013:31).

To determine participants' inclination to transfer, and to thus address research objective 4b, the TLO (Simper *et al.*, 2016) was also administered to each willing participant as a pre-test at the beginning of each meso-cycle and as a post-test at the end of each meso-cycle (see Figure 1.2). According to Simper *et al.* (2016:1173), the TLO was developed to measure students' propensity for lifelong learning. Simper *et al.* (2016:1162) identified transfer as a dimension of lifelong learning, along with motivation, learning belief, self-efficacy, and organisation. The TLO was designed as a triangulated measure consisting of four scale items for each dimension, as well as provision for an open-ended response, for validation and feedback to the instructor (Simper *et al.*, 2016:1165).

1.4.5.2 Interviews

According to Johnson and Turner (2003:305), when conducting semi-structured interviews as a method of collecting data, the interviewer creates a welcoming atmosphere and asks the interviewee a series of questions. When needed, an interviewee may be probed for more detailed information or clarification of answers (Johnson & Turner, 2003:305). In order to address research objective 4 (see section 1.3), focus group interviews and one-on-one interviews were conducted. The one-on-one interviews were anchored (Merriam & Tisdell, 2016:11) by participants' answers to the open-ended questions of the transfer tests (see section 1.4.5.3).

Interviews were conducted by the researcher at a convenient location at the university. Open-ended questions were asked in order for participants to "voice their experiences" (Creswell,

2008:225). As indicated by Creswell (2008:225), care was taken not to influence participants by any perspectives of the researcher or past research findings. Interviews were electronically recorded and then transcribed for analysis.

Analysis of qualitative data was done by using the software ATLAS.ti. Themes were identified (Gibbs, 2007:152) from analysing the transcribed interviews and the open-ended questions of the TLO. Gibbs (2007:152) defines a theme as an idea that occurs repeatedly. An inductive (Frieze, 2012:93) data-driven (Gibbs, 2007:45) coding approach was used to identify themes as well as a deductive coding (Frieze, 2012:93) approach. Codes were assigned to text as transcriptions were read, and emerging themes were identified. The deductive coding approach was directed by the categories of the TLO and the SRSSDL, and quotes applicable to those categories were sought during the coding process (Bazeley, 2010:440). Transcriptions were re-read, assigned codes were checked, and themes were re-evaluated (Morse *et al.*, 2002:13).

1.4.5.3 *Transfer tests*

In order to determine transfer of learning and to address research objective 4b, participants had to complete a transfer test after each intervention (see Figure 1.2). As this test was also part of the module's assessment plan, the test was administered to the whole population. However, only tests of willing participants were used for data collection purposes.

The transfer test can be described as a questionnaire consisting of open-ended questions. In open-ended terms, participants had to answer a transfer question in their own words (Johnson & Turner, 2003:303). Some questions required solving problems by using database software. A mark was allocated to each answer or solution, to quantitatively determine participants' transfer attempts (Lobato, 2003:18) and to provide a percentage obtained for the test.

The transfer tests were also used as anchored documents (Merriam & Tisdell, 2016:11) during the interviews, to obtain an understanding of the factors that hindered or promoted transfer (research objective 4c).

1.4.5.4 *Summary*

Data collection was done at specified intervals within each meso-cycle (see Figure 1.2). Quantitative and qualitative data collection instruments were used to obtain rich data and to address the relevant research aims and objectives. Themes that emerged from the data and results from the questionnaires were continuously reflected on, integrated and applied to subsequent interventions, to provide a theoretical framework for DSDL and to determine how DSDL can be developed. In Chapter 4, the research design and methodology of this study is elaborated on.

1.4.6 Reliability and validity

According to Stiles (1993:601), reliability concerns the trustworthiness of observations in qualitative data, and validity concerns the trustworthiness of interpretations or conclusions. Validity is further concerned with whether the quantitative measuring instruments have fulfilled their purpose and whether the instruments have measured what they were intended to measure, when the focus of the research is reflected on (Mertler, 2016:252; Patten & Newhart, 2017:123).

According to Creswell (2015:158), reliability is concerned with the trustworthiness of observations in qualitative data collection methods. As suggested by Morse *et al.* (2002:12), reliability was improved by interviewing as many participants as possible, seeking negative cases, and striving for data saturation and completeness of results. Validity of the data was ensured by means of triangulation. According to Delport and Fouché (2011:442), triangulation entails applying quantitative and qualitative methods in the same time frame and with equal weights, to understand and interpret the results. Qualitative data and quantitative data were analysed separately, and the results were then compared, to determine whether the results contradicted or supported each other, as indicated by Creswell (2008:447). The qualitative results were also used to provide a better understanding of the quantitative results.

When more than one group of participants is used, it can contribute to external validity, or transferability, of the research (Merriam & Tisdell, 2016:126). Therefore, another meso-cycle of the research was repeated in the following year on a different group of participants. Due to ethical considerations, it was not possible to have a control group of participants, as they might have been disadvantaged by being subjected to other teaching strategies. According to Bartsch (2013:30), external validity can also be improved by applying research in real classes, as was the case in this study.

Reliability of the quantitative data was ensured by determining the Cronbach's alpha coefficient of the SRSSDL (Williamson, 2007) and the TLO (Simper *et al.*, 2016) in the given contexts. The key to reliability of quantitative data is the repeated use of a measurement (Hunter & Brewer, 2003:581). Accordingly, reliability was addressed by administering the questionnaires to a different year group of participants in year 3 of the study (see Figure 1.1).

According to Merriam and Tisdell (2016:128), the validity and the reliability of research depend to a large extent on the ethics of the researcher. Accordingly, ethical guidelines, as discussed in the following section, were adhered to.

1.4.7 Ethical issues

Ethical clearance was obtained from the relevant ethics committee of the institution (see Appendix A and Appendix A(a)), prior to any data collection. Because this research required that an intervention be applied in an existing module which involved students from the university, permission to conduct the research also had to be obtained from the university's registrar for each year that data were collected. Such permission was granted, but with the prerequisite that the researcher was not allowed to collect any data, such as marks or contact details of participants, from any of the university's administrative systems.

All students that were registered for the module had to attend the classes, and they were thus subjected to the intervention. Participants were students that took part in the research voluntarily. The researcher facilitated the module. Care was therefore taken to respect this vulnerable population and to take into account potential power issues between the researcher and the population. Explanation of the research, recruitment of participants, and collection of letters of consent were therefore done by an independent person. Participants had the right to withdraw from the research at any time without incurring any consequences. However, as this was a compulsory module, participants were still obliged to attend the classes for the module.

When collecting data by means of questionnaires and transfer tests, participants' names or student numbers had to be recorded. This was only for the purpose of linking pre-tests with post-tests and to select participants for interviews according to the results of the transfer tests. Pseudonyms were assigned to participants in the transcribed interviews. At no stage during the dissemination of the research were the identities of participants disclosed. At all times confidentiality of participants and data enjoyed the highest priority, as suggested by Merriam and Tisdell (2016:134).

When conducting interviews, the interviewer strove to remain non-judgemental towards the responses of the interviewees, so as to obtain non-biased responses (Johnson & Turner, 2003:305). Interviews were conducted courteously and professionally (Creswell, 2008:229), and all possible measures were taken to ensure confidentiality and not to disclose the identities of participants (Creswell, 2008:238). Audio recordings were done with the permission of participants on two electronic devices, in the event of hardware failure. After recordings had been uploaded for storage, they were deleted from both devices. Recordings and transcriptions were done without identifying participants. Recordings, transcriptions, and data were stored on Google Drive, so as to have one password-protected central storage place that the researcher could access from various locations. Backups were also made on an external hard drive, which was stored in a safe location. The computer that was used to analyse the qualitative data was also password-protected.

According to Merriam and Tisdell (2016:133), analysing qualitative data also involves ethical issues. Researchers are the primary instruments for collecting qualitative data, and their views are filtered through their world views, theoretical positions and biases (Merriam & Tisdell, 2016:244). The researcher was constantly wary of excluding data because of personal biases. Coding was done with the research aims and objectives in mind, and transcriptions did not include identification of participants. Personal bias was therefore prevented as much as possible.

In this section, design research incorporating mixed methods research as the research design of this study was discussed. The research methodology was explained, and it was indicated who the participants were and what sampling procedure was followed. Finally, the data collection instruments, the measures to ensure reliability and validity, and ethical issues were discussed. A more elaborate discussion of the research design and methodology was done in Chapter 4.

1.5 CONTRIBUTION OF THIS STUDY

The contribution of this study was to provide a theoretical grounding for DSDL and to determine how DSDL can be developed in a database module in CAT education for higher education students. This study aimed to contribute to preparing students for the future and to ensuring their readiness for working in 21st-century environments, by nurturing the necessary competencies to develop DSDL. The results of the study were reported on in Chapter 5, followed by discussions of results and conclusions in Chapter 6.

The limitations of the study (see section 6.5) were that the interventions were only applied on CAT education students at a specific university, the suggested guidelines focused on database design, and use of control groups was not possible. According to Bartsch (2013:31), if the intervention has worked for one group, although it might not be successful for all cases, it can be said that it could be beneficial in some cases. Further research is recommended on larger populations of participants in database modules in other faculties (see section 6.6). Further research is also recommended to determine how DSDL can be developed in other subjects, for different year groups of students, and also for school learners.

1.6 STRUCTURE AND TIME FRAME OF THE THESIS

The thesis consists of the following chapters:

CHAPTER 1 – Introduction

CHAPTER 2 – Deeper learning: the rationale, the underlying theory, and the instructional practices

CHAPTER 3 – Proposing a theory for deeper self-directed learning

CHAPTER 4 – Research design and methodology

CHAPTER 5 – Reporting on the results

CHAPTER 6 – Discussion of results, conclusions, and recommendations

The completion of chapters was synchronised with the time frame of the research design. The time frame in which the thesis was completed, the research objectives that were addressed, and the phases of the research design are indicated in Table 1.3.

Table 1.3: Time frame of the thesis

Year, chapter(s), and research objectives addressed		Phase of the research design
Year 1: 2016	CHAPTER 1: Introduction	Analysis and exploration
Year 2: 2017	CHAPTER 2: Research objective 1	Analysis and exploration
Year 3: 2018	CHAPTER 3: Research objectives 1 and 2	Analysis and exploration Develop guidelines and design a prototype of the intervention
Year 4: 2019	CHAPTER 4: Research objectives 3 and 4 CHAPTER 5: Research objectives 3 and 4 CHAPTER 6: Research objectives 1 to 4	Reflect on the results, refine the guidelines, and adjust the intervention Dissemination of the research

1.7 CONCLUSION

This chapter provided an overview of this study. It was indicated that students need to be deeper self-directed learners in order to become lifelong learners in the 21st century. Numerous competencies in the cognitive, intrapersonal and interpersonal domains need to be developed. Students need to transfer knowledge and competencies and connect what they are learning in class to life beyond the classroom and take ownership and responsibility of their learning. This also applies to Computer Applications Technology education students at a higher education institution, who as future teachers have to apply their database knowledge to practice-related situations. The aim of this study therefore was to determine how DSDL can be developed in a database module in CAT education.

Deeper learning, self-directed learning, cognitive load theory and social constructivist theory were indicated as conceptual theoretical framework. To address the four sub-research questions, design research methodology with an embedded mixed methods design, that incorporated convergent and explanatory sequential mixed methods approaches, were applied over a four-year period. Data collection methods were described and an overview of the reliability, validity and ethical issues of this study were given. Lastly the contribution and limitations of this study were discussed and the time frame of this study was indicated.

CHAPTER 2:

DEEPER LEARNING: THE RATIONALE, THE UNDERLYING THEORY, AND THE INSTRUCTIONAL PRACTICES

2.1 RATIONALE

Education, and especially higher education, should contribute towards society, the workforce, and personal circumstances (Ellis *et al.*, 2018:1; Nixon, 2011:1; Perkins & Salomon, 2012:248). Nevertheless, much of the knowledge obtained in the classroom is not applied beyond the limits of the classroom (Goldstone & Day, 2012:149; Herrington & Herrington, 2006:2; Perkins & Salomon, 2012:248). Considerable research suggests that students generally fail to apply what they have learnt in the classroom to outside the classroom and to other disciplines (Chi & VanLehn, 2012:177; Goldstone & Day, 2012:149; Perkins & Salomon, 2012:248). According to Tulgan (2015:25), much of the blame can be placed on the education system and teaching, where lecturers and teachers often take the approach of teaching in the same way that they have been taught (Herrington & Herrington, 2006:2).

Education has the challenge of preparing learners for an unknown future, in a world characterised by change and complexity (Burden *et al.*, 2016:6; Ellis *et al.*, 2018:10). It is envisaged that by 2020 subject knowledge will be changing continuously and that new alliances between disciplines will be formed (Burden *et al.*, 2016:6). In the 21st century, knowledge and learning consist in far more than merely memorising facts and applying procedures, as acquisition of 21st-century skills has become an inextricable part of knowledge and learning (National Research Council (NRC), 2012:1). The real goal of teaching should therefore be for students to be thoughtful and adaptive (Goldstone & Day 2012:151) and to facilitate the development of transferable knowledge and skills that can “be applied in different real-life situations” (Kalyuga, 2009:332). However, according to Goldstone and Day (2012:151), learning scientists have mostly switched from one rote-procedure training system to another. It is accordingly argued that a change in mindset about the nature of knowledge and learning is required (Burden *et al.*, 2016:5; Perkins & Salomon, 2012:248; Voogt *et al.*, 2013:407).

To successfully face the challenges of the 21st century, students have to develop not only transferable knowledge but transferable skills (Ananiadou & Claro, 2009:7; NRC, 2012:2). A study conducted by the National Research Council (NRC) of the United States of America aimed to identify the skills and knowledge needed to succeed in the 21st century. The study concluded that deeper learning (DL) is a process for developing transferable knowledge and skills, also referred to as “21st-century competencies” (NRC, 2012:3). The outcomes of DL thus

include “content knowledge in a domain and knowledge of how, why, and when to apply this knowledge to answer questions and to solve problems” (NRC, 2012:6), as well as 21st-century competencies (NRC, 2012:74). Therefore, in the current study, the outcomes of DL will collectively be referred to as “transferable competencies”.

In this chapter a theoretical basis for DL will be suggested according to the definition of DL. The issue of transfer will then be discussed, as transfer of competencies is regarded as the outcome of DL. To conclude, strategies for promoting DL, and consequent transfer of competencies, will be discussed.

2.2 DEFINING DEEPER LEARNING

According to Biggs and Tang (2011:21), student learning research originated with Marton and Säljö's study of deep approaches and surface approaches to learning in 1976. Recently, with the growing challenges of the 21st century on education (Voogt *et al.*, 2013:403) and the need for 21st-century learning (Nehring & Szczesiul, 2015:327; Voogt *et al.*, 2013:407), deeper learning approaches have emerged from the literature (Bellanca, 2015; Ellis *et al.*, 2018:2; Huberman *et al.*, 2014; NRC, 2012). Thus, the concept of DL started to evolve. The purpose of this section is to work towards providing a theoretical grounding for DL, by exploring approaches to learning, the competencies required for DL, current research on DL, and learning theories underlying DL.

2.2.1 Approaches to learning

Traditionally, approaches to learning are referred to as deep approaches or surface approaches to learning (Biggs & Tang, 2011:21; Nelson Laird *et al.*, 2014:405; Varunki *et al.*, 2017). According to Biggs and Tang (2011:21), students that follow a deep approach to learning are academically committed and interested in their studies and want to do well. Such students come to lectures well prepared, and they reflect on the personal significance of what they are learning. As a result, they seek to grasp key concepts, understand their work in a broader context, and concentrate on analysing and relating ideas (Parpala *et al.*, 2013:202). According to Nelson Laird *et al.* (2014:403) and Varunki *et al.* (2017:331), the results of deep approaches to learning are that students manage to integrate information with prior knowledge, apply knowledge to real-world situations, and transfer ideas to different circumstances.

By contrast, students that follow a surface approach to learning try to memorise lists of facts, in order to be able to reproduce information, and they do not place a high priority on understanding (Biggs & Tang, 2011:22; Parpala *et al.*, 2013:201). It can thus be said that these students focus on rote learning of knowledge and are mostly just trying to cope with their studies and avoid failure (Nelson Laird *et al.*, 2014:403; Varunki *et al.*, 2017:331).

A third approach to learning, namely the strategic or achieving approach, has also been distinguished (Parpala *et al.*, 2013:202). In this approach, students apply organised study methods (Parpala *et al.*, 2010:278), linked to factors such as time management and goal achievement (Varunki *et al.*, 2017:332). According to Varunki *et al.* (2017:332), research has linked this approach to both surface and deep approaches of learning, and adoption of the strategic approach therefore does not guarantee good learning outcomes.

According to Biggs and Tang (2011:43), some learning-related aspects are controllable, and the challenge of teaching is therefore to change students' usual ways of learning, so that they adopt deep approaches to learning (Nelson Laird *et al.*, 2014:425; Wilmot & Merino, 2015:269). Studies have indicated that students in the natural sciences, such as physics and chemistry, where learning of facts is regarded as important, are inclined to follow a surface approach to learning, as opposed to students in the social sciences, who are more inclined to follow a deep approach to learning (Baeten *et al.*, 2010:243; Parpala *et al.*, 2010:270; Varunki *et al.*, 2017:332). There are, however, many subjects in the natural sciences that require problem-solving, and, conversely, there are subjects in the social sciences where factual knowledge is required. The natural sciences and the social sciences can therefore not be seen as two opposites in terms of the learning approach required, without taking other factors into account. A learning discipline can therefore not simply be indicated as a factor for adopting a surface approach, as other factors, such as motivation, self-regulation and the student's perception of the learning environment (Parpala *et al.*, 2010:270), age and gender (Rubin *et al.*, 2018:93), and the teaching strategy used (Wilmot & Merino, 2015:270), have also been shown to influence students' approach to learning.

Approaches to learning have been linked to levels of student engagement. Shulman (2002:38) states that learning “begins with student engagement, which in turn leads to knowledge and understanding”. When students are engaged, they tend to “select challenging tasks, show initiative in learning, [and] demonstrate intense effort and concentration” (Groccia, 2018:13), which can be related to deep approaches to learning. According to Groccia (2018:18), higher education should therefore apply ongoing efforts for active student involvement, as engagement operates on cognitive, affective and behavioural levels and increases motivation (Groccia, 2018:16). Point A of Figure 2.1 (Biggs & Tang, 2011:6) shows the difference between the levels of engagement between students that follow a deep approach to learning and students that follow a surface approach to learning. Point B in Figure 2.1 indicates that active teaching strategies, where students are required to apply a higher level of cognitive activities, such as relating and applying, can narrow the gap in levels of engagement (Biggs & Tang, 2011:6).

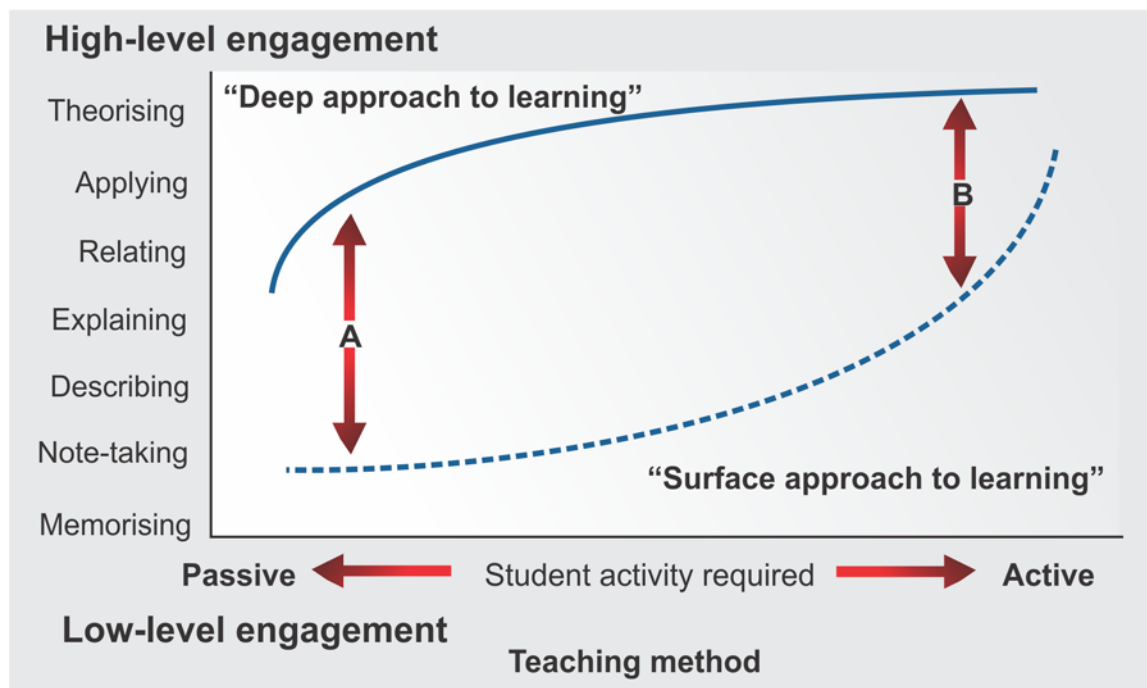


Figure 2.1: Student orientation, teaching method, and level of engagement (Biggs & Tang, 2011:6)

2.2.2 Competencies required for deeper learning

Apart from having implications for the choice of learning approach, the challenges of the 21st century also have implications for *what* has to be learnt (Voogt *et al.*, 2013:403). In this section the types of knowledge and skills required for DL will therefore be discussed.

2.2.2.1 Types of knowledge and skills required for deeper learning

Researchers have defined types of knowledge and have provided various classifications of knowledge. Anderson (1996:355), for instance, distinguishes between procedural and declarative knowledge. Procedural knowledge is generally defined as the knowledge of how to do something, perform tasks and solve problems (Nokes-Malach & Mestre, 2013:185; Pezzulo, 2011:89). Production rules that apply in problem-solving can therefore be indicated as procedural knowledge (Anderson, 1996:356; Nokes-Malach & Mestre, 2013:185). Declarative knowledge can be defined as the knowledge of what is true (Pezzulo, 2011:89). According to Anderson (1996:356), declarative knowledge is schema-like structures consisting of chunks of information. Flavell (1979:907) also distinguishes metacognitive knowledge, which is defined by Veenman *et al.* (2006:4) as declarative knowledge of the interactions between persons, tasks, and strategies.

According to Mishra and Kereluik (2011:3307), three key areas of knowledge have to be addressed in the 21st century: (1) foundational knowledge – core content knowledge of disciplines, information literacy, and cross-disciplinary knowledge; (2) meta knowledge – how

we act on the foundational knowledge, thus referring to problem-solving, critical thinking, communication, collaboration, creativity, and innovation; and (3) humanistic knowledge – that which we value. The latter includes knowledge of life, cultural competence, and ethical and emotional awareness.

Twenty-first-century knowledge, referring to skills and attitudes specially needed for living and working in the 21st century, are referred to as “21st-century skills” or “21st-century competencies” (Voogt *et al.*, 2013:404). There is no clear distinction in the literature between the terms “skills” and “competencies” (Allais, 2012:635). According to Adams (1987:41), researchers have for decades been struggling to define the phrase “a skill”. Although consensus has not been reached on exactly what a skill is and on the complexity that an activity should have to be defined as a skill, research agrees that a skill is something that can be learnt or acquired (Adams, 1987:42). To acquire a skill is, however, a process that takes time and effort (Veenman *et al.*, 2006:5).

The literature refers to different types of skills. *Soft skills* (Taylor, 2016:1; Tulgan, 2015:8) are generally seen as in contrast to *hard skills*, which more specifically refer to technical skills (Tulgan, 2015:8). There seems to be no generally accepted definition of soft skills (Taylor, 2016:3). Blume *et al.* (2010:1084) distinguish between *open skills* and *closed skills*. Examples of closed skills are computer software skills and skills involving simulations, such as flight simulator tasks, while examples of open skills include problem-solving and interpersonal skills, such as teamwork (Blume *et al.*, 2010:1078).

It is further necessary to elaborate on the terms “skills” and “competencies”. Some authors distinguish between the terms “skills” and “competencies” (Ananiadou & Claro, 2009:8; Beckett, 2018), but these terms can be regarded as having the same meaning. According to Voogt *et al.* (2013:404), either of the terms “skills” and “competencies” can be used, as researchers from Europe prefer the term “competencies”, while the term “skills” is preferred in North America. The NRC (2012:3) prefers the term “competency”, to indicate that knowledge and skills are intertwined. Accordingly, in this study, the term “21st-century competencies” will mainly be used, but the term “skill” will be used when referring to authors that have preferred to use the term “skill”.

2.2.2.2 Twenty-first-century competencies

Researchers worldwide agree that there seems to be a growing gap between the expectations of employees and the missing competencies among new young workers (Ananiadou & Claro, 2009:8; Ellis *et al.*, 2018:10; Taylor, 2016:2; Tulgan, 2015:4). According to Voogt *et al.* (2013:404), recent frameworks for 21st-century competencies generally agree that

collaboration, communication, digital literacy, citizenship, problem-solving, critical thinking, creativity, and productivity are seen as the more essential competencies. These so-called 21st-century competencies are, however, not exclusive to the 21st century (Mishra & Kereluik, 2011:3302; Tulgan, 2015:8), but have become increasingly important for work and life in the 21st century (Ananiadou & Claro, 2009:8; NRC, 2012:1; Voogt *et al.*, 2013:203).

Having lifelong learning skills is also widely recognised as a valuable attribute (Simper *et al.*, 2016:1159; Smith *et al.*, 2009:19). Lifelong learning can be defined as deliberate and continuous self-directed learning (Simper *et al.*, 2016:1159). Kirby *et al.* (2010:300) found that lifelong learners will more likely follow a deep learning approach. According to Kirby *et al.* (2010:293-294), lifelong learners should also be able to set goals, apply knowledge and skills, locate required information, and adapt learning strategies.

Although learning can be seen as a fundamental cognitive process, it has also been defined as a creative process resulting in the generation of new knowledge and skills (Wang, 2007:470). The Hewlett Foundation (2017) defines DL as

a set of six interrelated competencies: mastering rigorous academic content, learning how to think critically and solve problems, working collaboratively, communicating effectively, directing one's own learning, and developing an academic mindset — a belief in one's ability to grow.

The above competencies should, however, only be seen as a starter list of key skills required for DL (Bellanca, 2015:3). Because of the complex issue of learning, naming only six required competencies would be too simplistic. On the other hand, it would be a complex task to name all the competencies required for the process of DL. It therefore seems more appropriate to provide a classification of 21st-century knowledge, or in this context defined as competencies required for DL. The NRC (2012:31-35) suggests that competencies should be classified into three domains, namely the cognitive, the intrapersonal and the interpersonal domains. This classification is consistent with the suggestion of Smith *et al.* (2009:21) that professional education should be renewed by focusing on an apprenticeship of the head (where the focus is on cognitive development), an apprenticeship of the hand (where the focus is on implicit knowledge, such as communication and teamwork), and an apprenticeship of the heart (where the focus is on attitudes and values). In the following sections some key skills in the cognitive, the interpersonal and the intrapersonal domains (NRC, 2012:31-35) will be elaborated on.

2.2.2.2.1 Cognitive domain

Critical thinking is widely seen as an essential cognitive skill (Nelson Laird *et al.*, 2014:407; Smith *et al.*, 2009:19) for success in the 21st century, especially when problem-solving is

required (Bailey & Mentz, 2015:142). The ability to think critically and solve problems has even been described as a “survival skill” of “the new global ‘knowledge economy’” (Wagner, 2014:26). The 21st-century learner is exposed to unlimited information from various sources, and when applying critical thinking, learners should evaluate and criticise information and make judgements regarding information (Bailey & Mentz, 2015:142). As defined by Facione (1990:3), critical thinking also entails being able to interpret, analyse and make conclusions on the basis of evidence and reasoning.

The teaching of critical thinking can be regarded as elusive (Cypret-Mahach, 2018:161). Deliberate strategies have to be applied to improve students’ critical thinking (Bailey & Mentz, 2015:150). Some suggested teaching-learning strategies to foster critical thinking are cooperative learning (Bailey & Mentz, 2016:623; Malatji, 2016:34) (see section 2.4) and pair programming (Bailey & Mentz, 2017:90) (see section 2.4.1.3). According to Wagner (2014:26), the “habit of asking good questions” is often mentioned as an essential component of critical thinking, which will also assist in nurturing problem-solving competencies. Cypret-Mahach (2018:161) accordingly suggests that “essential questions” should be integrated in teaching to give meaning to facts and to create thought processes that encourage individuals to voice their personal opinions.

According to McTighe and Wiggins (2013:3), essential questions have seven defining characteristics: (1) they are open-ended; (2) they are thought-provoking and intellectually challenging, and will therefore spark discussion or debate; (3) they call for higher-order thinking; (4) they point towards important transferable ideas; (5) they raise additional questions, and therefore spark further enquiry; (6) they require support and justification; and (7) they recur over time – they should be revisited. The function of essential questions is, however, not to stimulate student thinking, but to deepen understanding and satisfy long-term transfer goals (McTighe & Wiggins, 2013:4).

According to Jahnke *et al.* (2017:87), no specific single definition of creativity can be found in the literature, but creativity can typically be seen as students expressing new ideas that are of value. Edmondson *et al.* (2012:41) define creativity as “a measurement of original thinking”. Johnson and Johnson (2013:347) view creativity as “the process of bringing something new into existence”.

Nelson Laird *et al.* (2014:407) identify the need for cognition and positive attitudes towards literacy as cognitive dimensions that should be developed in higher education. The need for cognition is associated with enjoyment of learning, and it can be defined as “the tendency to engage in and enjoy effortful cognitive activity” (Nelson Laird *et al.*, 2014:407). Positive attitudes

towards literacy refer to “reading widely and enjoying the learning process” (Nelson Laird *et al.*, 2014:407).

Other competencies that are classified under the cognitive domain are active listening, information and technology literacy, productivity, and innovation (NRC, 2012:32; Voogt *et al.*, 2013:404).

2.2.2.2.2 Intrapersonal domain

According to Denhardt (2001:530), intrapersonal skills are those capabilities that provide psychological and moral grounding for a person’s actions. Such skills will provide students with the confidence to apply what has been cognitively learnt, thereby building their confidence and self-esteem (Denhardt, 2001:530). Skills and characteristics in the intrapersonal domain include flexibility, adaptability, appreciation of diversity, social responsibility, intellectual curiosity, initiative, responsibility, integrity, metacognitive skills, self-monitoring, self-reflection, and self-efficacy (NRC, 2012:33, 139). It is beyond the scope of this study to elaborate on all the above-mentioned intrapersonal skills and characteristics, as they are rooted in the personality factors of openness, conscientiousness, and emotional stability (NRC, 2012:33), and they are therefore beyond the scope of this study. However, intrapersonal skills that apply to this research, such as self-efficacy, conscientiousness, openness, and metacognition, will be discussed.

Research has established that students’ self-efficacy plays a role in their academic motivation and learning (Zimmerman, 2000:82). According to Bandura (1977:193), an efficacy expectation is the conviction that behaviour can be successfully executed to produce certain outcomes. The strength of a student’s belief in their effectiveness, and their judgement of their capabilities, will most likely determine whether they will try to cope with situations, and to what extent they will persist in their efforts (Bandura, 1977:193-194). Accordingly, the more capable students judge themselves to be, the more challenges they may embrace (Zimmerman, 2000:87). It must, however, be noted that according to Bandura (1977:194), high self-efficacy alone will not produce the desired performance when capabilities and skills are lacking.

Conscientiousness can be defined as the tendency to be organised, responsible, and hardworking (NRC, 2012:29). Openness is considered the tendency to be open to new aesthetic, cultural and intellectual experiences (NRC, 2012:29). Metacognition is generally regarded as an essential characteristic of academically successful students, and it can also be seen as a collective noun for intrapersonal skills (McCormick *et al.*, 2013:69). Research has indicated that if metacognitive approaches are included in teaching practices, transfer of learning is improved (Clauss & Geedey, 2010:14; Zhao *et al.*, 2014:48).

Flavell (1976:232) defined metacognition as “knowledge concerning one’s own cognitive processes and products of anything related to them”. More commonly, metacognition can be defined as thinking about thinking (McCormick *et al.*, 2013:69). Students with metacognitive skills have various strategies for accessing their knowledge and acquiring new knowledge. They are able to monitor what they do not understand, and they can apply “effective strategies to improve their understanding” (McCormick *et al.*, 2013:69). These strategies should include developing a plan for learning, monitoring learning through reflection, and adjusting the plan accordingly, which will ultimately lead to deeper and more transferable learning (Zhao *et al.*, 2014:48). According to Veenman *et al.* (2006:4), several terms are commonly associated with metacognition, such as “metacognitive beliefs”, “metacognitive awareness”, “metacognitive knowledge”, “judgement of learning”, “higher-order skills”, and “self-regulation”. They further distinguish between metacognitive knowledge and metacognitive skills, where metacognitive skills are defined as “procedural knowledge for regulating problem-solving and learning activities” (Veenman *et al.*, 2006:4).

The term “metacognition” is sometimes used interchangeably with the term “self-regulation”, but there are significant differences between these two concepts (Dinsmore *et al.*, 2008:391; Veenman *et al.*, 2006:4). According to McCormick *et al.* (2013:70), metacognition is concerned with cognition and the knowledge and control of cognitive processes, while self-regulation is a broader concept that encompasses behavioural and emotional regulation and motivation. Self-regulation should not be viewed as an academic performance skill, but rather as the self-directive process by which a student transforms mental abilities into academic skills (Zimmerman, 2002:65). Self-regulated learners will approach learning in a proactive way, by setting goals, managing their time, doing self-evaluation, seeking help, and developing self-motivational beliefs and intrinsic task interests (Zimmerman, 2002:64-65).

2.2.2.2.3 Interpersonal domain

According to Voogt *et al.* (2013:405), interpersonal skills such as communication, collaboration, and responsible behaviour have always been integral to successful interpersonal relationships, but they take on a new dimension in the 21st century. Increasing economic, technological and environmental global interdependence requires increased cooperation between individuals, and the building of cooperative systems (Johnson & Johnson, 2014:850). In higher education, it is said that students who are socially integrated are more likely to persist with their studies and to demonstrate educational commitment (Smith *et al.*, 2009:20). Other skills mentioned with regard to the interpersonal domain are teamwork, leadership, decision-making, trust-building, and conflict-management skills (Johnson & Johnson, 2014:845; NRC, 2012:34; Smith *et al.*, 2009:19).

In the following section some current research regarding fostering of the above-mentioned competencies in the cognitive, the intrapersonal and the interpersonal domains in higher education will be discussed.

2.2.2.2.4 Competencies required in higher education

Research conducted in South Africa has indicated that students view communication, teamwork, leadership, and decision-making as the most important competencies to acquire (Taylor 2016:11; Viviers, 2016:254-255). Lecturers, however, have a different perception, and they perceive problem-solving, time management, communication, and critical thinking as the most important competencies for students in preparation for the workplace (Viviers, 2016:255). As far as industry is concerned, it perceives strategic thinking, verbal communication, and teamwork as the most important competencies (Viviers, 2016:255), and it indicates that the greatest shortcomings exist in communication, conflict management, and decision-making (Taylor, 2016:10).

According to students and lecturers of information technology at a South African university, critical thinking was not taught in their course, and no attempt was made to improve students' willingness to learn or to foster positive attitudes among students (Taylor, 2016:13). Students also indicated that communication and multidisciplinary thinking were neglected by lecturers (Taylor, 2016:11). Accounting students at another South African university also indicated that they were not receiving a high level of exposure to problem-solving, critical thinking, teamwork, leadership, influencing fellow students, and communication (Viviers, 2016:257). Figueiredo *et al.*'s (2017:1415-1416) research indicates that the demand for self-management skills is increasing in the workplace, and that graduates in future may be dissatisfied with their training.

In view of the above discussion, it can be concluded that research indicates a growing concern that higher education lacks the developing and fostering of crucial 21st-century competencies (Draeger *et al.*, 2015:215; Figueiredo *et al.*, 2017:1401; Nelson Laird *et al.*, 2014:425; Taylor, 2016:11; Viviers, 2016:257). It can thus be stated that students are not fully prepared for working and living in the 21st century.

In this section, DL was described as a process that focuses on the development of 21st-century competencies. Students need to apply deeper learning practices to become higher-order thinkers and to deepen their understanding of content, in order to transfer competencies to new situations (Bellanca, 2015:8-9). Although competencies have been classified into three domains, they are interrelated. For example, self-regulation can be seen as important for developing lifelong learning skills (Zimmerman, 2002:66). In the following section the focus will

shift to transfer of knowledge, as transferable knowledge is seen as the outcome of DL (NRC, 2012:74).

2.2.3 Transferable knowledge as an outcome of deeper learning

The NRC (2012:5) added the element of transferring knowledge as an essential 21st-century competency. It defines DL as “the process through which an individual becomes capable of taking what was learnt in one situation and applying it to new situations” (NRC, 2012:5). DL has also been defined by Bellanca (2015:7) as “learning for transfer”. DL is viewed as a twofold process that occurs within the *individual’s mind* and *through social interactions* within a learning community, resulting in “transferable knowledge and skills” (NRC, 2012:74). If the NRC’s view that skills and knowledge are intertwined (NRC, 2012:3) is incorporated, DL can be seen as resulting in transferable competencies.

In the following sections transfer will be discussed. Theories related to learning that support the process of DL as learning that occurs within the individual’s mind and through social interactions will then be discussed, to provide a theoretical basis for DL.

2.2.3.1 Perspectives on transfer

Although transfer of knowledge has been widely researched, debated and described by various authors, it remains a current issue in education, and an “elusive phenomenon” (Nokes-Malach & Mestre, 2013:184). Research into the phenomenon of transfer began with Thorndike’s identical elements theory of transfer in 1901, which was later revised by Singley and Anderson (1989) (Adams, 1987:44; Lobato, 2012:233; Nokes-Malach & Mestre, 2013:185). Thorndike and Woodworth designed an experiment where participants had to estimate the areas of different-sized shapes (Adams, 1987:44). Little evidence was, however, found of transfer of estimation from one shape to a different shape. They concluded that transfer of training is limited, and it is determined by the similarity between the original situation and the transfer situation (Adams, 1987:44). Currently, after more than 100 years of debate and research, transfer is still viewed as “a complex and dynamic process” (Blume *et al.*, 2010:1067), characterised by “significant variability in findings” (Blume *et al.*, 2010:1065).

Various definitions of transfer are found in the literature. The classical definition of transfer is that it is the capacity to use knowledge required in one context, referred to as prior knowledge (rules, examples, strategies, and constraints), to solve a dissimilar or novel problem in another context (Collard *et al.*, 2016:242; Nokes-Malach & Mestre, 2013:187; Norman, 2009:808). Transfer can also be defined as the effective and continuous application of knowledge and skills gained in learning activities (Merriam & Leahy, 2005:3). Adams (1987:44) defines transfer as

the learning of a response in one situation that influences the response in another situation. Nokes-Malach and Mestre (2013:185) view transfer as

a dynamic process in which the learner engages in the highly selective activation and application of knowledge to create a representation that allows him or her to make sense of the situation in order to accomplish a goal or perform some task.

In contrast to the mainstream cognitive definitions of transfer, as given above, other researchers view transfer from different perspectives. Lobato (2012:233) defines transfer as “the generalization of learning”, which means that learners’ prior activities have an influence on their activities in novel situations. Herrington *et al.* (2006a:191) view transfer by referring to situations that are conducive to transfer. According to Herrington *et al.* (2006a:191), transfer implies that favourable situations for transfer exist where students have the choice to apply knowledge they have learnt. They further state that when knowledge has not been transferred, it may be that the environment was “inadequate for transfer” (Herrington *et al.*, 2006a:191).

Although many definitions of transfer can be found, the central theme emerging from these definitions is that transfer is a continuous process, where learning in one situation influences a student’s response or problem-solving in another situation. It has already been mentioned above that various perspectives have emerged from the research on transfer (Belenky & Nokes-Malach, 2012:400; Goldstone & Day, 2012:149; Nokes-Malach & Mestre, 2013:187). Thus, in the following sections, the classical perspective on transfer, the actor-oriented transfer perspective (Lobato, 2012), and transfer as sense-making and satisficing will be discussed.

2.2.3.1.1 The classical perspective on transfer

According to Lobato (2012:233), research agrees that transfer occurs if the representations that students construct of “initial learning and transfer situations” are “identical, overlap, or can be related”. Perkins and Salomon (2012:252) thus state that three mental bridges have to be built when transferring knowledge. The bridges are named “detect”, “elect”, and “connect”. The student has to detect a link between a new situation and existing prior knowledge, they have to elect to pursue the link, and they have to make a connection. Accordingly, Herrington *et al.* (2006a:191) indicate that students choose to apply their knowledge, thus electing to pursue the link. Building the bridges of “detect”, “elect”, and “connect” can occur successively or concurrently, and not necessarily in any specific order. Although a student could have elected to pursue a link that has been detected, the “connect” bridge is regarded as the most difficult to build and to cross (Perkins & Salomon, 2012:252). Connecting is viewed as the final stage of transfer (Perkins & Salomon, 2012:252).

To develop a capacity for transfer is considered one of the most important aims of learning (Collard *et al.*, 2016:242; Pai *et al.*, 2015:82). Educational programmes assume that “knowledge acquired in them will transfer to situations outside the classroom” (Adams, 1987:44). Such programmes, however, often do not specifically account for transfer, and application of what has been learnt is “left to chance” (Merriam & Leahy, 2005:2). According to Norman (2009:808), students typically display a success rate of less than 30% in applying a learnt concept to a new problem. Transfer therefore remains a concerning issue (Dixon & Brown, 2012:1), and it is difficult to achieve (Merriam & Leahy, 2005:3; Norman, 2009:810; Pai *et al.*, 2015:82).

The literature distinguishes many types of transfer. Two broad categories of transfer have been identified, namely near transfer and far transfer (Johnson *et al.*, 2011:56; Merriam & Leahy, 2005:3; Nokes-Malach & Mestre, 2013:184). Near transfer occurs when knowledge and skills are applied in contexts similar to the contexts in which the learning occurs (Johnson *et al.*, 2011:56). Far transfer occurs when knowledge and skills are applied to new problems in different contexts to those in which knowledge or skills have been learnt (Johnson *et al.*, 2011:56). According to Merriam and Leahy (2005:4), the greatest interest of learning transfer is far transfer of deep structures.

Near transfer and far transfer are also called “surface transfer” and “deep transfer”, respectively. Deep structure and surface structure transfer are especially mentioned with regard to problem-solving (Chi & VanLehn, 2012:178; Merriam & Leahy, 2005:3). Structure refers to the similarities of a situation, which can either lie on the surface or at a deep level. When similarities lie on the surface, the transfer situations are identical and have the same relational structure, as surface structure refers to the concepts, objects or context described in a transfer problem (Chi & VanLehn, 2012:178; Nokes, 2009:3). As already mentioned, problem situations are transferable when similarities at a deep level exist (Chi & VanLehn, 2012:181). Deep-structure similarities refer to the rules or procedures for solving the problem (Chi & VanLehn, 2012:178; Nokes, 2009:3). However, when similarities are at a deep level, deep knowledge is required (Perkins & Salomon, 2012:252), as the original learning situation and the transfer situation do not look identical, making transfer difficult for novices. According to Perkins and Salomon (2012:252), deep knowledge entails that a deep understanding has been developed in the original context of learning.

Also of importance is the ability to compare and identify similarities and differences between transfer situations correctly. Chi and VanLehn (2012:181) describe the following possible transfer outcomes through the identification and comparison of surface and deep structures. Although surface structure may seem to be the same, differences at a deep level can exist (see Figure 2.2). In such circumstances transfer cannot be done, because of the differences at a

deep level. Novices, who can often be misled by surface similarities, may therefore incorrectly want to apply transfer.

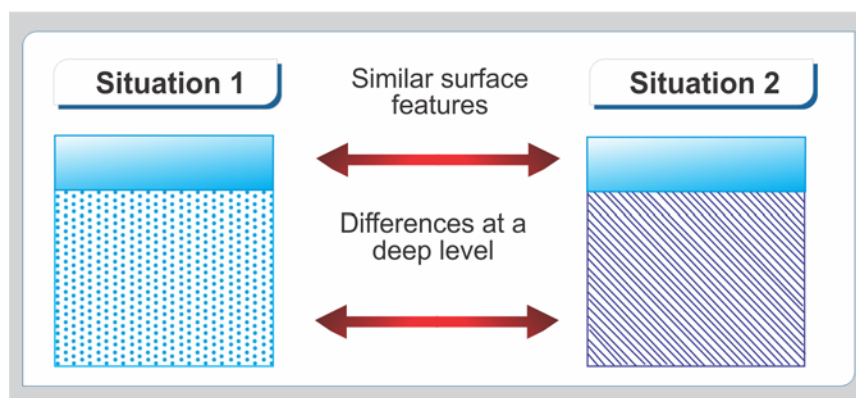


Figure 2.2: Situations where transfer cannot be done
(Source: own contribution)

Conversely, although surface features of two situations may seem to differ, similarities at a deep level can exist (see Figure 2.3). In such situations, transfer can be done (Chi & VanLehn, 2012:181).

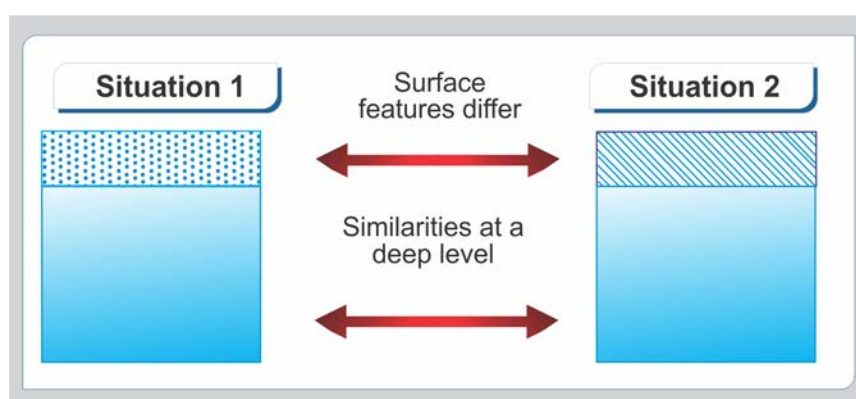


Figure 2.3: Situations conducive to transfer
(Source: own contribution)

Research has shown that if abstract knowledge or schemas can be constructed, the probability of transfer increases (Lobato, 2012:233; Nokes-Malach & Mestre, 2013:186). Such schemas should allow students to identify similar deep structures between situations (see Figure 2.3), enabling them to apply transfer in problem-solving situations (Chi & VanLehn, 2012:181). When transfer is done between tasks that use the same knowledge but in different ways for different goals, it is referred to as declarative transfer (Nokes-Malach & Mestre, 2013:186). For declarative transfer to occur, similar deep structures therefore need to have been identified. A deep understanding of learning content is thus regarded as the basis of transfer (Chi &

VanLehn, 2012:180; Perkins & Salomon, 2012:252). Students often understand that they need to make connections, but even though they are motivated to make connections, they fail to develop connections when they cannot perceive deep-feature similarities (Chi & VanLehn, 2012:179).

In terms of the result of transfer that has been applied, transfer can be described as failed transfer or positive transfer, negative transfer or overzealous transfer (Schwartz *et al.*, 2012:204-205). These terms will be explained briefly. When transfer has not occurred, it is usually described as failed transfer (Schwartz *et al.*, 2012:205). By contrast, when determining transfer sensitively, and not only as a once-off answer to a problem situation, the possibility exists that supporting evidence for attempted transfer, or positive transfer, has been found (Schwartz *et al.*, 2012:205). According to Lobato *et al.* (2012:437), performing poorly on transfer tasks is often referred to as failed or negative transfer. Schwartz *et al.* (2012:205) provide a more refined and alternative description of negative transfer, by describing it as transfer that has been made to an inappropriate situation. Negative transfer is also seen as interference in learning, which consequently hinders new learning and problem-solving (Schwartz *et al.*, 2012:205).

According to Schwartz *et al.* (2012:206), overzealous transfer occurs when students have applied transfer that is working well enough with respect to the task at hand but is, in effect, suboptimal transfer, as it is obstructing new learning. For example, students apply complex solutions to problems and do not notice more efficient simple solutions. Overzealous transfer indicates that students tend to rely on their complex mental sets, instead of seeking simpler solutions (Schwartz *et al.*, 2012:206). If a student does not receive negative feedback on overzealous transfer, Schwartz *et al.* (2012:206) claim that they may view this as positive transfer, not as negative transfer.

In trying to understand transfer, one should also take into account the type of knowledge that has to be transferred, and the mechanisms or processes used to transfer that knowledge (Nokes, 2009:31). Knowledge that has to be transferred is distinguished by Nokes (2009:4) as exemplar knowledge, instructional knowledge, or constraint-based knowledge. Exemplar knowledge can be explained as knowledge that is typical to other examples (Merriam-Webster, 2017). Exemplar knowledge is thus similar to surface structures, as described above. Instructional knowledge refers to declarative knowledge, which can be described as procedural knowledge that includes instructions and tactics (Nokes, 2009:3). Declarative knowledge thus resembles deep structures. Constraint-based knowledge refers to knowledge of the constraints of a certain domain, which can be explained simply by referring to the rules of a game (Nokes, 2009:4).

According to Nokes (2009:29), different types of transfer situations will trigger different transfer mechanisms, depending on an individual's prior knowledge and the characteristics of the transfer task. Nokes-Malach and Mestre (2013:185-187) distinguish four well-researched mechanisms of transfer, namely identical rules, analogy, knowledge compilation, and constraint violation. Each of these mechanisms accounts for specific processes and representations in transfer problems (Nokes-Malach & Mestre, 2013:186). These four mechanisms will be briefly explained.

According to the mechanism of *identical rules*, transfer is “determined by the number of overlapping production rules” (the procedural knowledge of “knowing how to perform tasks”) between two tasks (Nokes-Malach & Mestre, 2013:186). The second mechanism of transfer, *analogy*, is described as the application of three processes (Nokes-Malach & Mestre, 2013:186). In describing analogy, it can be related to the three mental bridges of “detect”, “elect”, and “connect” (Perkins & Salomon, 2012:252), as explained above. Analogy can be explained as (1) retrieving a prior example (“detect”), (2) creating an alignment and mapping between the prior example and representation of the new problem (“elect”), and (3) drawing an inference appropriate to the new problem (“connect”).

Analogies can transfer declarative or procedural aspects of knowledge, and they can be used in near-transfer and far-transfer situations (Nokes-Malach & Mestre, 2013:186). Research suggests that for novices, analogy is triggered by tasks that are similar on the surface (Nokes, 2009:3). Therefore, analogy is often used by novices in near-transfer situations (Nokes-Malach & Mestre, 2013:186). Novices should therefore specifically be guided during instruction to recognise similarities and possible transfer situations, and to make abstract representations in order to recognise deep-structure similarities in far-transfer situations (Lobato, 2012:233; Nokes-Malach & Mestre, 2013:187).

According to Collard *et al.* (2016:249), repeated experience with the same information but in different contexts will assist in identifying the similarities between problems. Research conducted by Kurtz and Loewenstein (2007:338) has shown that when students compared two unsolved problems, analogical retrieval between the two problems was facilitated, allowing them to obtain a more abstract understanding of the problem. Their research further illustrates that students do not need to learn everything correctly the first time when aiming to ultimately achieve successful analogical retrieval and transfer (Kurtz & Loewenstein, 2007:338). Goldstone and Day (2012:150), however, argue that transfer is not only influenced by the similarities between situations, but also by the inclination of a student towards transfer and making connections.

The third mechanism of transfer, *knowledge compilation*, interprets prior declarative knowledge and processes it into procedures that can be used to solve new problems (Nokes-Malach & Mestre, 2013:187). Transfer thus involves knowing *how* to use knowledge as well as *when* to use knowledge (NRC, 2000:235). In the fourth mechanism, *constraint violation*, a student uses prior knowledge of domain constraints to generate a new solution, evaluates the solution by taking knowledge of constraints into account, and then revises the solution (Nokes, 2009:3). It is, however, worth mentioning at this point that concerns have been raised that knowledge compilation and constraint violation can cause performance errors, because of the limitations of the working memory (Nokes-Malach & Mestre, 2013:187). These concerns will be clarified in section 2.3.1.4, in the discussion of enhancement of transfer in view of the cognitive load theory.

Both knowledge compilation and constraint violation are time-consuming mechanisms of transfer, requiring a high level of cognitive processing in comparison to analogy, which is usually fast and efficient (Nokes, 2009:5). Students will therefore adapt and use different transfer mechanisms as required by the transfer tasks and the transfer scenarios (Nokes, 2009:32). It is thus suggested that multiple measures and different transfer tasks should be used to assess transfer (Nokes, 2009:30). In this regard, the classical perspective on transfer has been criticised as not being able to account for and assess all aspects of transfer. Nokes-Malach and Mestre (2013:188) argue that the classical perspective on transfer does not capture the real-world aspects of transfer. They further argue that the classical perspective does not account for the types of reasoning novices engage in when attempting transfer, that little attention is given to individual differences in how students frame activities and relate to learning situations, and that knowledge to be applied is seen separately from students' motivation, social situations, and environmental resources (Nokes-Malach & Mestre, 2013:188). Two perspectives on transfer that aim to address the mentioned gaps in the classical perspective on transfer are the actor-oriented transfer (AOT) perspective (Lobato, 2012) and the transfer as sense-making perspective (Nokes-Malach & Mestre, 2013). These perspectives will be discussed in the following two sections.

2.2.3.1.2 The actor-oriented transfer perspective

According to Lobato (2012:234), the actor-oriented transfer (AOT) perspective was not intended as a criticism against the classical perspective on transfer, but rather as an alternative perspective, where semantically rich content, susceptible to various interpretations, is involved. In the AOT perspective, also referred to as the actor's point of view, the student is seen as the actor and the researcher as the observer. The researcher does not measure transfer against predetermined cognitive outcomes or behaviours determined by the researcher, or the observer

(Nokes-Malach & Mestre, 2013:188), but tries to determine how prior knowledge and experiences have shaped the student's activity in the transfer situation. Thus, even if the result of transfer would be seen as incorrect (negative transfer) from a classical transfer or observer's perspective, the AOT perspective aims to capture the nature of a student's reasoning on transfer tasks, and the social processes that have contributed to the connections that the student has constructed (Lobato, 2012:235, 239). Researchers thus look for ways in which students have attempted transfer, or have indicated that they have thought about applying transfer, based on their interpretation and meaning-making of the activities and events in their initial learning situation and social interactions, paying attention to individual differences (Lobato, 2012:234, 241; Nokes-Malach & Mestre, 2013:188).

From the AOT perspective, transfer is defined as the generalisation of learning, or the influence of prior learning activities on students' activities in novel situations (Lobato, 2012:233). According to Lobato (2012:235), the AOT perspective is especially suited for studying the transfer practices of novices, as novice students can often make unexpected connections between their interpretations of learning experiences and transfer situations. Novices are also likely to demonstrate a greater variety of interpretations of learning environments than experts (Lobato, 2012:235). One aspect that Lobato *et al.* (2012:476) advocate to enhance transfer is more discourse opportunities within groups, in order for students to share the different aspects of scenarios that they notice.

2.2.3.1.3 Transfer as sense-making and satisficing

Nokes-Malach and Mestre (2013:188) view sense-making and satisficing as a cyclical process of transfer in problem-solving scenarios. This process consists of a set of general strategies that influence transfer through “the construction of context and the evaluation of potential solutions” (Nokes-Malach & Mestre, 2013:189). Each stage of the process is driven by sense-making, which means to determine if task goals have been accomplished to the student's satisfaction, “based on coordination of prior knowledge with information from the environment and the framing of the task” (Nokes-Malach & Mestre, 2013:185). Along the way, the student continually has to evaluate the solution to determine if it satisfies the goals, in order to decide if the transfer process should stop or should continue (Nokes-Malach & Mestre, 2013:188).

In their framework for transfer, Belenky and Nokes-Malach (2012:400) mention satisficing as part of the transfer process. According to Nokes-Malach and Mestre (2013:188), satisficing is “the idea that people rarely produce an optimal solution” to a problem, but instead generate solutions to accomplish certain goals. Accomplishment of goals can be seen as a motivational aspect of transfer (Belenky & Nokes-Malach, 2012:400). Motivation has been widely identified as a factor affecting transfer (Blume *et al.*, 2010:1065; Merriam & Leahy, 2005:5), and it can be

defined as the desire to use the knowledge and skills learnt in a task (Noe, 1986:743), or the reasons students engage in activities in a domain (Belenky & Nokes-Malach, 2012:426). Without motivation to transfer, Gegenfurtner *et al.* (2009:403) argue that newly acquired knowledge and skills will rarely be applied. Incorporation of satisficing thus has implications for answering the questions of how, when and why transfer succeeds or fails, by investigating the student's achievement and motivational goals (Belenky & Nokes-Malach, 2012:426; Nokes-Malach & Mestre, 2013:191).

Belenky and Nokes-Malach (2012:400) distinguish two broad categories of goals that can motivate transfer, namely mastery-approach goals and performance goals. Mastery-approach goals focus on developing understanding and competence and attaining a skill, while performance goals focus on demonstrating a skill, and thus on performing better than others (Belenky & Nokes-Malach, 2012:400; Nokes-Malach & Mestre, 2013:190). Research by Belenky and Nokes-Malach (2013:30) suggests that mastery-approach goals rather than performance goals will facilitate transfer. Research also indicates that a deep understanding of knowledge and skills, which is seen as an outcome of the mastery approach, will influence transfer (Johnson *et al.*, 2011:67; Perkins & Salomon, 2012:252). In this section, the two parts of transfer as sense-making and satisficing, namely constructing a representation of the context and evaluating potential solutions, will be explained.

Nokes-Malach and Mestre (2013:191) claim that they have a more expansive view than the classical perspective on transfer in terms of the structural features of transfer tasks. Transfer as sense-making and satisficing addresses issues related to the classical perspective on transfer, such as capturing the real-world aspects of transfer, individual differences, the role of the learning phase, and the types of reasoning a novice engages in when attempting transfer (Nokes-Malach & Mestre, 2013:188). In transfer as sense-making and satisficing, the features of the task, as well as the student's framing of the task, are included when constructing a representation of the context (Nokes-Malach & Mestre, 2013:191). The student's framing of the task will thus refer to the student's prior knowledge, experiences, beliefs and motivational goals for a certain learning situation (Nokes-Malach & Mestre, 2013:191). Bandura (1977:212) thus stated that students will apply their individual choice of behaviour to a task as an outcome of how they have processed, weighed and integrated different sources of information regarding their perceived self-efficacy.

Different individuals will therefore frame tasks differently and will activate and apply different knowledge and solution strategies to similar problems (Nokes-Malach & Mestre, 2013:191). Research on transfer has similarly concluded that the student's view of learning (Goldstone & Day, 2012:150), their self-efficacy, or their belief that they have the skill and the ability to

transfer (Halpern & Hakel, 2003:39; Merriam & Leahy, 2005:6), the transfer conditions (Dixon & Brown, 2012:2), and the student's metacognition (Georghiades, 2004:379; Papaleontiou-Louca, 2003:20) influence transfer. Accordingly, different transfer mechanisms (identical rules, analogy, knowledge compilation, or constraint violation) (see section 2.2.3.1.1) will be applied in different contexts, as influenced by the student's framing of the tasks (Nokes-Malach & Mestre, 2013:192).

The second part of transfer as sense-making and satisficing deals with generating a solution to the problem. As explained above, a specific transfer mechanism will be triggered to develop a solution. The solution then needs to be evaluated by the student by means of satisficing (determining if the solution fulfils either mastery-approach goals or performance goals), which, in turn, can again trigger a transfer mechanism. The generated solution can also again impact the representation of the context, and vice versa (Nokes-Malach & Mestre, 2013:203).

Transfer as sense-making thus focuses on the construction and application of knowledge in problem-solving scenarios especially with regard to novice performance, which often does not agree with an expert's solution to a transfer problem, as in the AOT perspective (Lobato, 2012:234; Nokes-Malach & Mestre, 2013:203). It further focuses on how a student frames a problem and makes sense of the solution, assuming that the knowledge constructed and applied is a function of the activities, situations and social interactions in which it was acquired (Nokes-Malach & Mestre, 2013:203). Once again, as in the AOT perspective, transfer as sense-making also aims to explain transfer in view of the motivational goals that have implicated it.

In this section some perspectives on transfer have been discussed. In the following section, a brief review will be given of factors influencing transfer.

2.2.3.2 A review of factors influencing transfer

After many decades of research, there is still a need to identify the factors and the strategies that enhance transfer in education (Blume *et al.*, 2010:1097; Herrington *et al.*, 2006a:183). Some factors that have in recent years been indicated as increasing the likelihood of transfer will therefore be discussed.

According to Schwartz *et al.* (2011:770), the model of instruction employed is a large contributor to transfer. They sampled articles on transfer in the fields of mathematics learning and science learning published between 2003 and 2008, and they found that 75% of the studies used a telling-and-practice teaching strategy for both treatment and control variables in transfer studies, while they manipulated other variables (Schwartz *et al.*, 2011:770). In a telling-and-practice strategy students are first told about certain concepts, and they then have to practise or apply these concepts. Schwartz *et al.* (2011:770) argue that in a telling-and-practice strategy, a deep

structure of concepts will in most cases not be learnt. Their research indicates that when students first explore novel deep structures and are only told afterwards what experts or teachers know, transfer is improved (Schwartz *et al.*, 2011:772).

Blume *et al.* (2010:1065) did a meta-analysis of 89 studies that explore the impact of factors such as trainee characteristics, work environment, and interventions on transfer of training of employees. They found that transfer is influenced by variables such as cognitive ability, conscientiousness, motivation, learning outcomes, and a supportive transfer climate (Blume *et al.*, 2010:1065). However, when comparing studies within the same context and looking through a more precise quantitative lens, they found that there are a limited number of strong predictor relationships with transfer. Strong predictors were the types of skills that were trained and the timing of the transfer measurements (Blume *et al.*, 2010:1089). They further found that cognitive ability had the single largest relationship with transfer, and that personal characteristics, such as conscientiousness, pre-training self-efficacy, and motivation to learn, had moderate relationships with transfer (Blume *et al.*, 2010:1090). According to Blume *et al.* (2010:1096), there are no simple answers to transfer, as there is a lack of consistency to support a specific transfer intervention. They therefore suggest combining various strategies for transfer, and that transfer interventions must be longer and more impactful (Blume *et al.*, 2010:1096).

Grossman and Salas (2011:103) used the research of Blume *et al.* (2010) as a basis and aimed to identify the individual characteristics, the training design, and the environments that exhibited the most consistent and the strongest relationships with transfer. They identified cognitive ability, self-efficacy, and motivation as having strong relationships with transfer. Their research also indicated that when training is perceived as useful and valuable, trainees are more likely to transfer, or apply, what has been learnt (Grossman & Salas, 2011:107). Behaviour modelling is also mentioned as an effective strategy to facilitate transfer (Grossman & Salas, 2011:111). Transfer is especially mentioned when trainees design their own scenarios for modelling behaviours (Taylor *et al.*, 2005:694). Grossman and Salas (2011:107) furthermore suggest that opportunities to practise skills should be provided, including error management and how to anticipate and handle problem situations in realistic, positive and negative environments. Regarding realistic environments, a short discussion follows on using an authentic approach to learning.

Several views of an authentic approach to learning exist (Herrington & Herrington, 2006:3), but it is argued by Herrington and Herrington (2006:3) that cognitive authenticity rather than physical authenticity is most important when designing authentic learning environments. Simulation of a real-world situation should therefore rather promote a realistic problem-solving process as being similar to the physical environment (Herrington & Herrington, 2006:3).

Authentic activities are accordingly described by Herrington *et al.* (2006b:4-6) as ill-defined activities and complex tasks that are relevant to the real world, which have to be completed over a sustained period of time within collaboration settings with other students. When providing an authentic context for activities, it reflects the way knowledge will be used in real life, and it also gives students the opportunity to model real-world practice and examples of how experts perform tasks (Herrington *et al.*, 2006b:4). Authentic tasks have been shown to enhance motivation and to provide meaning and relevance to academic work (Parsons & Ward, 2011:462-463), factors that, in turn, have been indicated above as having a positive relationship with transfer. Transfer of learning is thus regarded as an outcome of authentic learning (Herrington *et al.*, 2006a:182; Lombardi, 2007:4).

In this section, an attempt has been made to define DL, by discussing approaches to learning, types of knowledge and skills required for DL, and transfer of competencies as an outcome of deeper learning. Some perspectives on transfer have been discussed, including the classical perspective on transfer and more recent views of transfer, namely the actor-oriented transfer perspective and transfer as sense-making and satisficing. Lastly, factors affecting transfer have been discussed.

Blume *et al.* (2010:1066) stated that positive transfer of training to the workplace determines the effectiveness of the training. This statement can also be applied to teaching and learning when having to acquire certain competencies. Rephrasing this statement from a deeper learning perspective, it can be stated that the transfer of competencies will determine the depth of learning, and it can be considered the real measure of achievement in education (Eisner, 2001:370).

In the following section, an attempt will be made to suggest a theory underpinning DL, by discussing cognitive load theory and social constructivist theory. These two theories are envisaged as providing a basis for DL.

2.3 TOWARDS A THEORY OF DEEPER LEARNING

Mayer (2008:761) stated that the science of learning should be integrated in the science of instruction. Therefore, in order to be able to design instruction aimed at DL, theoretical views on learning should be integrated. In the following sections some views and theories of learning will therefore be explored in order to provide a theoretical foundation for DL. As DL is described as a process that occurs within an individual's mind and within social interactions in a community (NRC, 2012:24), the discussion will focus on these two aspects of learning, by describing cognitive load theory (CLT) and social constructivist theory (SCT).

2.3.1 Cognitive load theory

According to Mayer (2008:761), learning “depends on the learner's cognitive processing during learning”. Cognitive processing can be explained simply as the learner selecting the incoming material, organising the incoming material into a “mental representation”, and then relating the incoming material to information in their long-term memory (Mayer, 2008:761). CLT (Sweller, 1988) relates to Mayer's description of cognitive processing during learning and is often mentioned with regard to learning (Janssen *et al.*, 2010; Kirschner *et al.*, 2018; Mason *et al.*, 2016; Paas *et al.*, 2003). According to Paas *et al.* (2010:116), CLT has become an influential theory regarding instructional design, especially where the learning of complex cognitive tasks is concerned.

Complex tasks can be described as tasks where a large number of elements have to be processed simultaneously (Paas *et al.*, 2010:116). Complexity of tasks is increased when “redundant information” or “ambiguous relations” between elements are present (Könings *et al.*, 2019:87). When learning complex tasks, an overwhelmingly number of elements “need to be processed simultaneously”, which can impact on meaningful learning (Paas *et al.*, 2010:116). CLT thus focuses on instructional control of the “excessively high load imposed by complex tasks” (Paas *et al.*, 2010:116). In the following sections, CLT will be discussed by referring to two types of memory in the human mind, namely long-term memory (LTM) and working memory (WM), the interaction between LTM and WM, and incorporation of CLT in instructional design.

2.3.1.1 Long-term memory and working memory

CLT (Sweller, 1988) uses current knowledge about human cognitive architecture, and it describes the process of learning as an interaction between LTM and WM in the minds of individuals (Paas *et al.*, 2010:116). LTM is said to have virtually unlimited capacity (Sweller *et al.*, 2011:19), and it is used to store knowledge in the form of schemas (Mason *et al.*, 2016:69). A schema is defined as a “cognitive construct”, where multiple elements of information can be combined into a single construct and become one element again (Chi *et al.*, 1982; Sweller, 2011:22-23). According to Nokes-Malach and Mestre (2013:186), a schema can also be seen as a knowledge representation of a problem that captures the original or the typical elements of the problem. The different individual elements of a problem that need to be solved can thus be treated as a single element by a schema that has previously been acquired to solve a problem (Sweller *et al.*, 2011:23). Competencies can be acquired because of information held in the LTM (Sweller *et al.*, 2011:22). Advanced knowledge and skills are thus acquired after many cycles of forming new schemas (Paas *et al.*, 2003:1-3).

According to Sweller *et al.* (2011:19), research by De Groot (1965) and Chase and Simon (1973) indicated that many higher-level cognitive activities are largely driven by schemas in the

LTM. Such schemas can therefore render difficult problems easy to solve, as the LTM provides templates to effortlessly solve problems (Sweller *et al.*, 2011:23). However, when a learner identifies an inappropriate schema to solve a problem, the problem can seem to be difficult to solve (Sweller *et al.*, 2011:23).

The WM is used to process and integrate information with existing schemas in the LTM. Unlike the LTM, the WM is limited in duration and capacity (Paas *et al.*, 2010:117). According to Sweller *et al.* (2011:43), research by Peterson and Peterson (1959) found that almost all information in the WM is lost after approximately 20 seconds. Therefore, new material should constantly be rehearsed to be held in the WM indefinitely, as this will assist in transferring the information to the LTM (Sweller *et al.*, 2011:43). Regarding processing capacity, research has indicated that the WM is limited to less than nine elements (Choi *et al.*, 2014:226; Cowan, 2010:51). Sweller *et al.* (2011:43), however, dispute this and argue that no more than three items of new information can be processed by the WM at a given time, because of the combinatorial number of elements that the WM should deal with.

The limitations of the WM, however, only apply to new information. As soon as content in the WM has been integrated with existing schemas in the LTM, new knowledge is stored as new schemas in the LTM, which can again be integrated with new content in the WM (Paas *et al.*, 2010:117; Sweller *et al.*, 2011:44). Therefore, when dealing with familiar information in the LTM, the limitations of the WM do not apply (Choi *et al.*, 2014:226).

In view of the above, the aim when designing instruction according to the CLT is to take into account the characteristics of the WM and the LTM. Unnecessary load on the WM should be reduced to ensure that the limited WM resources are directed towards the essentials of the curriculum (Sweller *et al.*, 2011:45). Research has also shown that improving and managing WM resources can enhance transfer of learning (Paas & Van Gog, 2006; Van Merriënboer *et al.*, 2006; Waris *et al.*, 2015:1). As the LTM is considered to have a considerable role in problem-solving and thinking (Sweller *et al.*, 2011:22), a further aim of instruction according to the CLT is therefore to acquire a large knowledge base in the LTM (Paas *et al.*, 2010:116). An assumption of the CLT to take into account when designing instruction is that almost all knowledge and schemas stored in the LTM are borrowed from other people (Sweller *et al.*, 2011:28, 30) and do not have to be gained from experience (Paas *et al.*, 2010:116).

According to Sweller *et al.* (2011:54), the cognitive architecture, as described above, is vital for instructional design decisions. Information presented to increase knowledge in the LTM should take into account the limitations of the WM. Unnecessary processing of the WM, and cognitive loads that place a burden on the WM, should be reduced. By contrast, the cognitive resources

used in memory for learning should be increased (Sweller *et al.*, 2011:6). In the following section, the different types of cognitive load and resources will be discussed.

2.3.1.2 Types of cognitive load

During processing of instructional information and learning, the available resources in the WM will be allocated to two main types of cognitive load, namely intrinsic cognitive load and extraneous cognitive load (Choi *et al.*, 2014:227; Paas *et al.*, 2010; Sweller *et al.*, 2011). Germane cognitive load is often mentioned as a third type of cognitive load (Kirschner *et al.*, 2009a:36), but currently the term “germane resources” is suggested (Choi *et al.*, 2014:227; Kalyuga, 2011:1; Sweller *et al.*, 2011:57). Germane resources are seen as part of the intrinsic cognitive load that is devoted to learning. In the following sections intrinsic cognitive load, extraneous cognitive load and germane resources will be elaborated on. A discussion will then follow on balancing of these loads.

2.3.1.2.1 Intrinsic cognitive load

Intrinsic cognitive load (see Figure 2.4) is imposed by the nature and the structure of information, and it is affected by the difficulty of the content (Sweller *et al.*, 2011:57) and the expertise of the learner (Van Merriënboer *et al.*, 2006:343). Complex content that has to be learnt requires that complex schemas be acquired, and it therefore causes a higher intrinsic cognitive load (Paas *et al.*, 2010:117). Thus, if a high number of elements needs to be processed simultaneously, the intrinsic cognitive load will be high, and learning will become difficult and WM resource-intensive (Choi *et al.*, 2014:227). Learning material requiring low-element interactivity requires less WM resources, and learning will consequently be easier (Paas *et al.*, 2010). According to Van Merriënboer *et al.* (2006:344), intrinsic cognitive load is also determined by the expertise of the learner. For a high-expertise learner, a problem may consist of only a few elements, while for a low-expertise learner the same problem may consist of numerous elements.

2.3.1.2.2 Extraneous cognitive load

Extraneous cognitive load is imposed by the way in which information is presented and the activities that students are required to engage in (Sweller *et al.*, 2011) (see Figure 2.4). The instructional design can therefore also impose unnecessary extraneous cognitive load on the WM if it has not been designed to take the cognitive architecture into account (Choi *et al.*, 2014:227; Sweller *et al.*, 2011:57) and keep the extraneous cognitive load as low as possible. According to Van Merriënboer *et al.* (2006:343), extraneous cognitive load is not required for learning, and it typically results because of poorly designed instruction.

2.3.1.2.3 Germane resources

The term “germane resources” refers to WM resources devoted to dealing with learning (Sweller *et al.*, 2011:57), and therefore with the intrinsic cognitive load (the difficulty of the content) (Choi *et al.*, 2014:227). Thus, the more germane resources available for learning, the more WM resources available for learning and the more effective learning will be. Therefore, in an ideal learning situation, where learners are optimally engaged in learning, optimal use will be made of germane WM resources (Kalyuga, 2011:15).

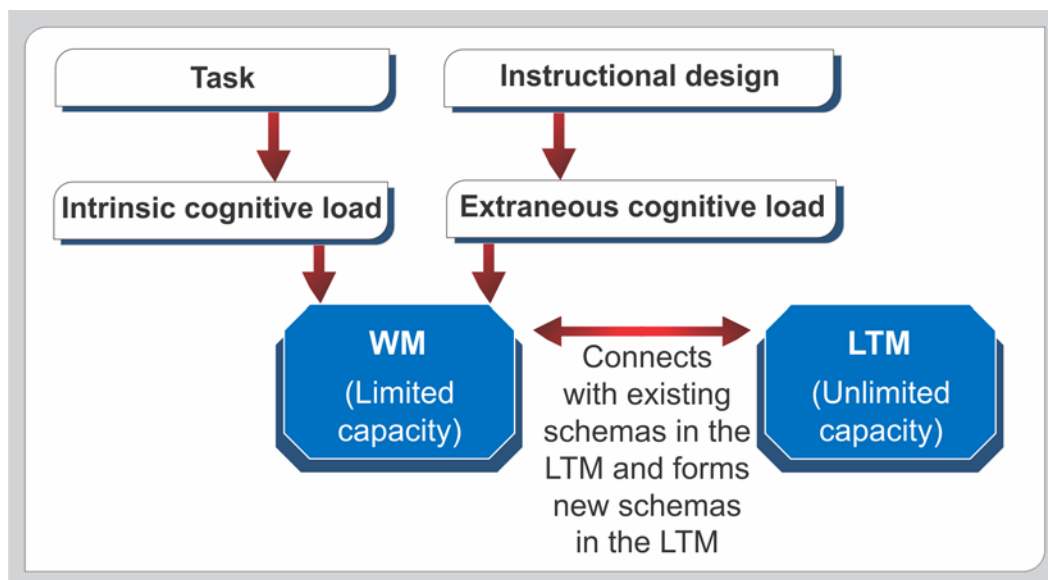


Figure 2.4: Cognitive load theory
(Source: own contribution)

2.3.1.2.4 Balancing the cognitive load

Because the WM has limited capacity and resources, the balance between the intrinsic cognitive load and the extraneous cognitive load will affect learning. Although the extraneous cognitive load does not hamper learning when the intrinsic cognitive load is low (more WM resources are available), it does hamper learning when the intrinsic cognitive load is too high (Van Merriënboer & Sweller, 2005:150). Thus, too many WM resources will be used to deal with the extraneous cognitive load, and not enough germane resources will be available to deal with the high intrinsic cognitive load, and thus with learning. Therefore, when the intrinsic cognitive load is high, the extraneous cognitive load should be reduced, in order to provide more capacity for germane resources, which will result in more effective processing of the WM, and thus more effective learning (Paas *et al.*, 2010:117-118; Van Merriënboer *et al.*, 2006:344). Interaction with schemas in the LTM will occur, and schemas will be updated (Janssen *et al.*, 2010:144). However, although the extraneous cognitive load may be eliminated, the intrinsic cognitive load may still be too high for the WM resources in the event of difficult learning content. The intrinsic cognitive load should therefore also be managed by instructional design, to allow simultaneous

and balanced processing of all elements in the WM (Paas *et al.*, 2010:118; Van Merriënboer *et al.*, 2006:348).

Poor instructional design with inappropriately balanced cognitive loads interferes with schema acquisition (Paas *et al.*, 2010:117), and thus with learning. It is possible that a student may be using the entire pool of WM resources to deal with the instructional processes only (Sweller *et al.*, 2011:58). According to Kalyuga (2009:336), “deep learning for transfer depends on the interaction between” the intrinsic cognitive load and the germane resources. Instructional design should therefore be intentionally designed in such a way that the germane resources are not constrained by the intrinsic cognitive load. In the following section the implications of the CLT on instructional design will be discussed.

2.3.1.3 *Implications of the cognitive loads on instructional design with special reference to collaborative learning*

When designing instruction according to the CLT, the goal should be to provide maximum capacity to the WM, in order to devote germane resources to learning (Kalyuga, 2011:15). Factors such as learner characteristics, learning-task characteristics, and the physical environment have been identified as some main factors contributing to cognitive load (Choi *et al.*, 2014:225; Van Merriënboer *et al.*, 2006:349-350). The sum of the intrinsic cognitive load and the extraneous cognitive load determines the WM resources needed to process information. If the total cognitive load therefore exceeds the available WM resources, the cognitive system will not process information optimally, and the germane resources will be too low to deal with the intrinsic cognitive load (Sweller *et al.*, 2011:58).

“Scaffolding” has become an important concept to balance the cognitive load. Because novices “have not yet developed cognitive schemas”, support is needed to reduce the cognitive load imposed by complex tasks (Könings *et al.*, 2019:86). The purpose of “scaffolding” is to provide full support to novices at the start of instruction, which is then gradually reduced (Könings *et al.*, 2019:86). Significant research has indicated that “scaffolding” of domain-specific skills reduces cognitive load and improves performance in learning (Könings *et al.*, 2019:92). Optimal guidance is required to prevent misconceptions or incomplete knowledge (Kirschner *et al.*, 2006:84). It is thus argued that novices should be provided with “extensive guidance” (Kirschner *et al.*, 2006:80), which can be relaxed once expert knowledge in long-term memory has been acquired (Kirschner *et al.*, 2006:80).

In view of the CLT, worked-out examples can provide “scaffolding” for novice students (Könings *et al.*, 2019:86). Worked-out examples are considered the highest level of support that can be provided to learners, and they present learners with “a given state, a goal state, and a full

solution to be studied or evaluated” (Van Merriënboer & Kirschner, 2018:71). Van Merriënboer and Kirschner (2018:71) suggest that worked-out examples of complex tasks are first issued to novice students. Worked-out examples should then be followed up by completion tasks, where learners are provided with partial solutions (Van Merriënboer & Kirschner, 2018:74). Finally, conventional tasks are introduced, where learners have to develop a full solution to the problem (Van Merriënboer & Kirschner, 2018:81). According to Kalyuga (2009:333), some benefits of studying worked-out examples are “deeper task understanding and meaningful problem-solving”, “lower instruction time and higher efficiency”.

Research by Mason *et al.* (2016:83) has shown that restructuring course content in view of the CLT leads to better understanding of concepts, and thus transfer to other courses. Their research was done on an introductory database course. Although the course content stayed the same, they significantly reduced the extraneous cognitive load, by sequencing topics to better assist schema construction, providing suitable worked-out examples, distributing core concepts throughout the various topics, and placing greater focus on the underlying purpose of concepts in both theory and practice (Mason *et al.*, 2016:84). This approach relates to the “holistic design approach” described by Van Merriënboer and Kirschner (2018:5), with the view that “the whole is considered more than the sum of its parts” (Van Merriënboer & Kirschner, 2018:5). The focus when structuring course content should thus be on the interrelatedness of elements, and not on reducing content to simple facts and skills (Van Merriënboer & Kirschner, 2018:5).

Collaborative, or group, learning can also be considered an option to provide more processing capacity to the WM (Kirschner *et al.*, 2009b:311), and it may be an effective means to increase flexibility and transferability of knowledge and skills (Kalyuga, 2009:334). In a collaborative learning setting the intrinsic cognitive load is divided across the working memories of the collaborating group members (Janssen *et al.*, 2010:149; Kirschner *et al.*, 2009b:311) (see Figure 2.5). The intrinsic cognitive loads on individual group members will thus be reduced in collaborative learning environments. From the CLT perspective, Kirschner *et al.* (2009a:38) view groups as “information processing systems consisting of multiple collaborating working memories”. Kirschner *et al.* (2018:220) state that a collective working memory, having a larger capacity than individual working memories, will exist when a group functions appropriately. Group members should be dependent on each other and should be communicating and coordinating their knowledge (Kirschner *et al.*, 2018:220). In these conditions, and when complex tasks have to be solved, collaboration will become a “scaffold” for knowledge acquisition (Kirschner *et al.*, 2018:220), and will thus be beneficial to learning.

Apart from learning domain-specific knowledge, group members have to learn “how to collaborate” (Kirschner *et al.*, 2018:221). Collaborative settings require transactive activities,

which can be described as activities that concern the proper functioning of the group (Kirschner *et al.*, 2018:223). Examples of transactive activities are deciding which tasks have to be allocated to which group members, communicating, resolving conflict, and achieving consensus (Kirschner *et al.*, 2018:225). According to Gillies (2014:130), groups often struggle with knowing what to do, and group members have to deal with managing the group process as well as the demands of the task.

Concerns have been raised that managing group activities will add to the extraneous cognitive load of group members (Janssen *et al.*, 2010:143). Kirschner *et al.* (2009a:31), however, argue that the gain achieved by the division of labour can outweigh the cost of a higher extraneous cognitive load. However, too much extraneous cognitive load exerted by a collaborative setting will be harmful to learning (Kirschner *et al.*, 2018:220). Factors such as the size of the group, differences in prior knowledge of group members, and previous collaborating experiences of group members can all add to the extraneous cognitive load (Kirschner *et al.*, 2018:225). When the size of the group increases and group members have less experience on the task at hand or on working with others in a group setting, more transactive activities are required, thus increasing the extraneous cognitive load (Kirschner *et al.*, 2018:225).

Figure 2.5 shows how the intrinsic cognitive load of a task is shared by the working memories of two group members, reducing the intrinsic cognitive load on each individual. Figure 2.5 also indicates the extraneous cognitive load added to each group member, due to transactive activities.

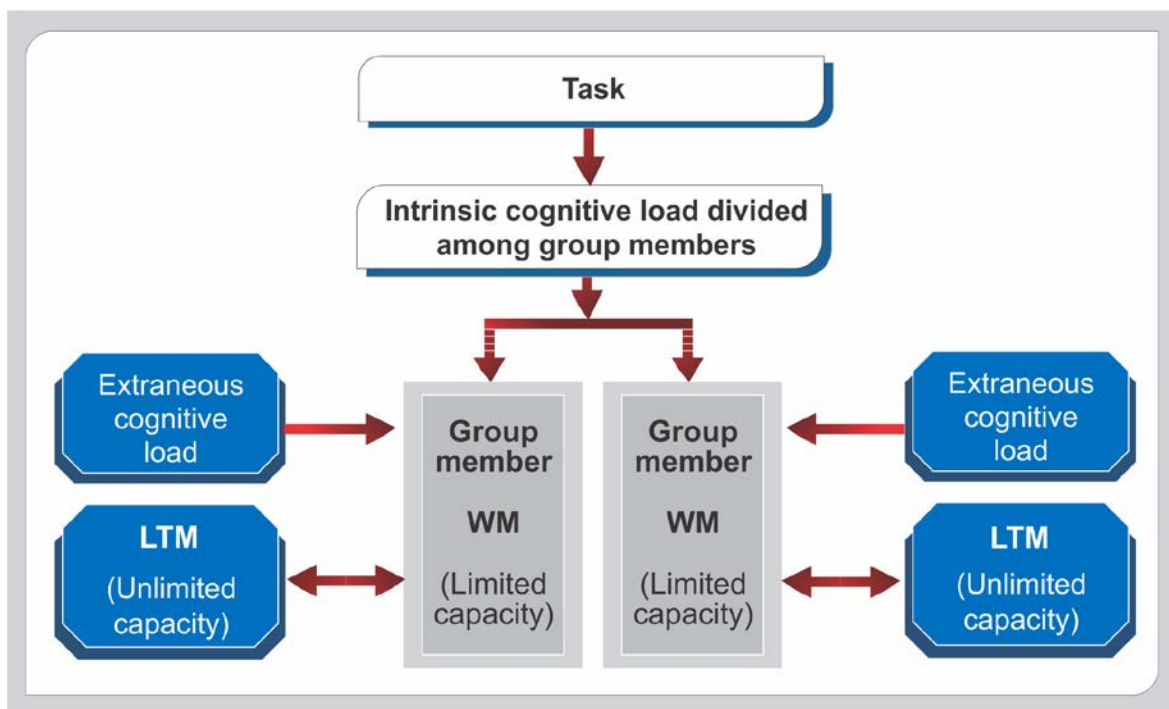


Figure 2.5: Collaborative learning in view of the cognitive load theory
(Source: own contribution)

As indicated above, specific conditions are mentioned to optimise collaborative learning in view of the CLT to reduce the extraneous cognitive load. According to Janssen *et al.* (2010:145), learning in a collaborative setting will only be more effective than learning individually if the “distribution advantage is large enough to compensate for the extraneous transaction costs”. Conditions regarding task complexity, learner characteristics and group characteristics have to be taken into account to take advantage of shared cognitive processing (Janssen *et al.*, 2010:145; Kirschner *et al.*, 2018:228). These conditions will therefore be discussed.

Kirschner *et al.* (2018:226) define a collaborative learning task as a “concrete, authentic whole-task learning experience that has to be completed within a given period of time in collaboration with other learners”. Collaborative learning tasks should be demanding and complex enough to necessitate working together (Janssen *et al.*, 2010:145; Kirschner *et al.*, 2011:615). For sufficient complexity of tasks in group settings, two prerequisites are suggested by Kirschner *et al.* (2018:218). The task should be complex (it should require high interactivity of elements), and learners working on the task should not be experts (Kirschner *et al.*, 2018:218). Many elements and aspects of prior knowledge should therefore be integrated in a collaborative task issued to novice learners, for the task to be complex enough. The extraneous cognitive load will thus be reduced, because the element interactivity (the intrinsic cognitive load placed on individual

group members when solving complex tasks) in a group setting is less than when working in individual settings (Kirschner *et al.*, 2018:223).

Levels of prior knowledge, familiarity with other group members, and previous experiences in working in group settings are also mentioned as factors to consider when taking learner characteristics into account (Janssen *et al.*, 2010:149; Kirschner *et al.*, 2018:228). Kirschner *et al.* (2018:227) therefore distinguish between domain-specific expertise (levels of prior knowledge) and collaboration skills (acquired from previous collaboration experiences). According to Choi *et al.* (2014:225), learners' prior knowledge will differ, and the number of schemas in LTM of each group member will therefore differ. The intrinsic cognitive load of a medium-ability student may therefore increase when they explain to a high-ability student. The high-ability student, in turn, will experience an increase in their extraneous cognitive load, as they are already aware of this information being explained, which then becomes redundant (Janssen *et al.*, 2010:150). Sweller (2011:155-156) refers to the "expertise reversal effect", which occurs when information that is beneficial to novice learners can be redundant to expert learners, thus leading to unnecessary processing of information by the expert learners and an increase in extraneous cognitive load. Kirschner *et al.* (2018:222) therefore suggest that the task being issued to the group should be complex enough and should exceed the WM capacity of each individual group member.

Differences in learning characteristics are often mentioned when discussing composition of groups. Various possibilities for group composition have been suggested. Denessen *et al.* (2008:380) showed that medium-ability students performed better when collaborating with low-ability students, compared to when they collaborated with high-ability students. Regarding familiarity between group members, positive consequences have been shown for the way in which group members collaborate (Janssen *et al.*, 2009:27). When group members are unfamiliar with each other, the extraneous cognitive load may increase because of the need to coordinate their actions (Janssen *et al.*, 2010:149). Research by Zhang *et al.* (2016:188) indicated that students with less prior knowledge could benefit from working in groups of students with different levels of prior knowledge. Zhang *et al.*'s (2016:171, 188) study indicated that heterogeneous groups were more effective for learners with lower levels of prior knowledge than both homogeneous groups and individual learning. No differences were reported for learners with high levels of prior knowledge (Zhang *et al.*, 2016:171).

Kirschner *et al.* (2018:226) point out that learners who are not experienced in working in groups experience a higher extraneous cognitive load, due to transactive activities. To improve collaboration between learners that are not experienced in working together, Fischer *et al.* (2013:64) suggest that groups should be provided with collaboration scripts. The purpose of

collaboration scripts is to provide guidance to inexperienced groups, and collaboration scripts should not be seen as limiting spontaneous collaboration (Fischer *et al.*, 2013:64). Collaboration scripts will guide inexperienced groups on how to effectively work together – how to organise information and distribute activities among group members (Kirschner *et al.*, 2018:221). Thus, when guidance and support are built into the task, fewer transactive activities will be required, thus reducing the extraneous cognitive load (Kirschner *et al.*, 2018:228). However, care should be taken not to allow collaboration scripts to distract learners' attention and thereby limit deep processing of content (Kirschner *et al.*, 2018:222).

From the above discussion, it can be said that characteristics of group members will play a role in the characteristics of the group. Other factors are also mentioned with regard to group characteristics, such as the roles that group members have to carry out and the size of the group (Kirschner *et al.*, 2018:227). When roles are allocated to group members and when the size of the group is smaller, the extraneous cognitive load will be lower (Kirschner *et al.*, 2018:225).

In the above discussion, the CLT has been discussed, as well as the implications of the CLT on instructional design. The advantages of using collaborative learning in view of the CLT, especially with regard to complex tasks, have also been discussed, as well as instructional design issues that should be taken into account when designing instruction according to the CLT. In view of the above, a synergy must be found between task complexity, group composition, and the characteristics of individual group members to balance the intrinsic cognitive load and the extraneous cognitive load (Kirschner *et al.*, 2018:229).

In the following section, research on improving transfer in view of the CLT will be discussed.

2.3.1.4 Enhancing transfer in view of the cognitive load theory

According to Van Merriënboer *et al.* (2006:346), instructional methods that have improved performance on retention tests and acquisition of knowledge, such as practising one version of a task repeatedly, “step-by-step guidance”, and “frequent and complete feedback”, will not have a positive effect on problem-solving and knowledge transfer. This is described as the transfer paradox (Van Merriënboer *et al.*, 2006:346). Thus, when designing instruction for transfer of knowledge, it should be done in a specific manner and differently from when designing for performance in retention tests. Thus, in order to teach for transfer, a change of mindset about knowing and learning is required (Perkins & Salomon, 2012:257). In view of the CLT, the extraneous cognitive load and the intrinsic cognitive load of learning complex tasks should be reduced initially, to provide for more germane resources that can be devoted to learning (Van Merriënboer *et al.*, 2006:345).

When executing complex tasks, the intrinsic cognitive load early in the initial learning process can be so high that little or no processing capacity is left for students to develop internal metacognitive processes and cognitive schemas (Van Merriënboer *et al.*, 2006:345), thus interfering with forming the basis for transferable knowledge. As frequent feedback can lead to cognitive overload, one way of reducing the cognitive load and enhancing transfer is to give limited feedback and guidance (Van Merriënboer *et al.*, 2006:345).

When comparing and contrasting examples to identify deep structure similarities, even more transfer gain can be obtained (Hatala *et al.*, 2003:25; Kurtz & Loewenstein, 2007:334; Norman, 2009:809; Schwartz *et al.*, 2012:208). Schwartz *et al.* (2012:210) accordingly suggest that instructional practices should focus on building a deep basic understanding of concepts, by guiding students through inquiry activities first and doing some problem-solving, instead of following a tell-first approach. It is further recommended that learners be exposed to a variety of learning conditions that include a variety of problems and solutions, to be practised in random order (Halpern & Hakel, 2003:39; Van Merriënboer *et al.*, 2006:346). Key ideas will then be retrieved in multiple ways, which will enhance schemas in the LTM (Halpern & Hakel, 2003:39). Although this may result in harder initial learning, and longer initial learning, the learning and the transfer gain can be significant (Halpern & Hakel, 2003:39; Schwartz *et al.*, 2012:209).

Regarding the above discussion, Van Merriënboer *et al.* (2006:349) have developed a four-component instructional design model (4C/ID) for learning environments for complex tasks that aims for transfer of learning. The 4C/ID model suggests that a whole-part approach should be followed for learning tasks, indicating that learning tasks should be ordered in task classes. From the first task class, “whole and meaningful tasks” should be given, in order for learners to develop a holistic view of the whole task (Van Merriënboer *et al.*, 2006:349). Each subsequent task should then be more complex and should require more knowledge than the preceding simpler task class. This means that “scaffolding” will take place within the element interactivity of the task classes, as earlier task classes will have lower element interactivity than subsequent task classes. From the outset, learners’ attention should be focused on those elements that are most important for learning. Ordering learning tasks in simple to complex task classes enables the use of instructional methods that provide more germane resources, and that thus balance the intrinsic cognitive load.

In summary, when designing instructional methods specifically for transfer for complex tasks in view of the CLT, learning tasks should right from the outset show high variability of practice, provide limited feedback and guidance, and be structured in task classes, to provide a holistic view.

2.3.1.5 Summary

According to the CLT, the human mind's cognitive architecture consists of a very limited WM and a seemingly unlimited LTM. During learning, the intrinsic cognitive load and the extraneous cognitive load impose on the WM. The aim of instructional design in the context of the CLT is to provide maximum germane resources to handle the intrinsic cognitive load and to reduce or eliminate the extraneous cognitive load. Restructuring course content and learning in a collaborative setting was suggested as a possible way of reducing the extraneous cognitive load and providing optimal germane resources. "Scaffolding" by means of worked-out examples was discussed, as well as the collaboration scripts for novice groups. Research on instructional design in view of the CLT, specifically to improve transfer, was also discussed.

The above discussion of the CLT focused on a theory relating to the first part of the definition of DL, namely as a process that occurs within an individual's mind. The second part of the definition of DL states that DL is also a process that occurs within social interactions within a learning community (NRC, 2012:74). In view of this definition and research aim 1, namely to propose a theory for DL, social constructivist theory will be discussed.

2.3.2 Social constructivist theory

Social constructivist theory (SCT) describes learning as a process that occurs through social interaction (Thomas *et al.*, 2014:2). More specifically, according to Murphy *et al.* (2005:342), SCT as described by Vygotsky (1978:90) assumes that "knowledge construction is achieved by the interaction that takes place within oneself through reflective thinking and by the interaction that occurs in communications and collaboration with other people". Failing to recognise the social process and the many ways in which experienced learners can share knowledge with less experienced learners can limit the intellectual development of students, as this will exclude the possibilities that social facilitation brings to learning (John-Steiner & Soubberman, 1978:126).

Social constructivist theory should be clearly distinguished from social constructionist theory. According to Thomas *et al.* (2014:3), social context is at the centre in social constructionism, and the influence that culture has on people is emphasised. Accordingly, people have definite views of the world, shaped by culture and context. By contrast, within a social constructivist paradigm, the individual is placed at the centre of the meaning-making experience, where learning takes place because of the individual's interaction within a specific social context (Thomas *et al.*, 2014:3).

The roots of social constructivist theory lie in the research of Vygotsky (1978). According to Vygotsky (1978:86), all people have a zone of proximal development, defined as "the distance between the actual development level [that which a person can do or know at that stage] and

the level of potential development”, which can be obtained in collaboration with more capable peers. It can thus be said that we are always maturing and have more potential capabilities. Therefore, what we would probably be able to do at a later stage on our own account can be mastered earlier by collaborating with peers.

Damon (1984:332) also describes the views of Piaget and Sullivan on the influence of peer interactions on intellectual development. According to Damon (1984:333), Piagetian theory states that peer interaction works as a trigger for change, as feedback from peers prompts individuals to re-examine their own perspectives and justify their own beliefs, which introduces new thought patterns and intellectual reconstruction. Damon further states that according to Sullivan, peers approach each other as equals, are closely matched in knowledge and ability, and generally do not have an authority relationship. They accordingly learn from each other by sharing ideas, they compromise willingly, they make mutual plans, and they are open to each other's insights (Damon, 1984:334).

According to Murphy *et al.* (2005:342), “learning through interaction with others” requires that students engage actively in exchanging ideas and meaning negotiation, “by looking at and reflecting on the multiple perspectives” of fellow students. It is through such communicative interaction that students learn, by being exposed to the perspectives of their peers, which clarifies their ideas and thus fosters application of the material that has been learnt (Stearns, 2017:72). This application of knowledge also implies transfer of knowledge. As discussed in section 2.3.1.4, one aspect that is important for transfer of knowledge is that a learner should be exposed to a variety of views or insights on a specific concept in order to obtain a deeper understanding. It is within this multiplicity of perspectives, which is considered a premise of social constructivist learning (Stearns, 2017:72), that transfer of knowledge and learning is developed.

In this section the SCT, which posits that learning occurs in interaction with peers, was discussed, to provide a theoretical grounding for the second part of the definition of DL, which states that DL is a process that occurs through social interactions within a learning community. It is thus concluded that the CLT and the SCT provide a theoretical grounding for the two-part definition of DL.

Both CLT and SCT suggested collaborative learning as a teaching-learning strategy to improve transfer. Cooperative learning is a specific form of collaborative learning. In the following section a motivationalist discussion will subsequently be given on cooperative learning, as an appropriate teaching-learning strategy to foster DL.

2.4 COOPERATIVE LEARNING

According to Trilling and Fadel (2009:108), forms of collaborative learning practices “have a more significant impact on student performance than any other variable, including student background and prior achievement”. When students are collaborating on challenging activities, they are doing tasks that prepare them for real professions (Herrington & Herrington, 2006:2). Halpern and Hakel (2003:40) and Wirth (2007:1) argue that lecturing does not promote in-depth understanding, and that it is therefore not optimal for fostering deep learning. Halpern and Hakel (2003:40) further state that understanding is an interpretive process, in which students have to be active participants.

Cooperation as social interdependence promotes, among other things, higher levels of achievement, retention and transfer, positive relationships, attitudes, and values (Johnson & Johnson, 2017:284). However, the mere placing of learners or students in groups and requiring them to work together does not necessarily promote cooperation and have the desired learning outcomes (Baloche & Brody, 2017:276; Gillies, 2014:129). In the search for effective ways to promote cooperation, learning, and student achievement, extensive research has been done since the 1970s (Baloche & Brody, 2017:274; Gillies, 2014:127; Johnson & Johnson, 2017:287; Kyndt *et al.*, 2013:134; Slavin, 2011:344). As a result, cooperative learning (CL) has been defined and has become a widely accepted and recognised approach for collaborative learning (Baloche & Brody, 2017:275, 276; Slavin, 2011:43), confirmed by a vast body of research (Wirth, 2007:1). CL has further been confirmed as an appropriate pedagogy for preparing student teachers to be effective in their professional teaching careers (Johnson & Johnson, 2017:285).

The terms “cooperative learning” and “collaborative learning” are often used interchangeably (Jacobs, 2015; Janssen *et al.*, 2010:140; Pai *et al.*, 2015:80), and they therefore need to be clarified in the context of this study. According to Kyndt *et al.* (2013:134), the terms “cooperative learning” and “collaborative learning” were initially used by authors to distinguish between the age groups of learners and between the types of knowledge to be learnt. Collaboration was described as a philosophy of interaction, as opposed to cooperation, which was described as a structure of interaction (Kyndt *et al.*, 2013:134). In this study, however, the term “CL” will specifically be used to refer to a structured form of collaborative learning in small groups (Kyndt *et al.*, 2013:135). CL differs from traditional group work in the way it is structured to ensure that each member of the group contributes to the group’s goal (Jolliffe & Snaith, 2017:307) and each member is held accountable for the complete content of the task (Felder & Brent, 2007:34). CL as a structured form of group work was further designed to prevent traditional problems with group work. Social loafing occurs when only some students in the group do all the work (Slavin,

2011:397). Partial knowledge also often occurs, where group members have only done parts of the assignment and have little or no knowledge of what the other group members have done (Felder & Brent, 2007:34).

In the following section, some theoretical perspectives on CL will be discussed, in order to provide explanations for the positive effects of CL on student achievement, learning, and development of various competencies.

2.4.1 Theoretical perspectives on cooperative learning

Slavin (2013:179) identified four theoretical perspectives on the achievement effects of CL, namely the motivationalist theory, the social interdependence theory, the cognitive-developmental theory, and the cognitive elaboration theory. Although each theory provides a different perspective on CL, Slavin (2013:180) suggests that these perspectives should be viewed as complementary to each other, rather than as contradictory to each other. In this section these perspectives will be briefly discussed.

The motivationalist theory will be discussed first, as described by Slavin (2013:181). Motivationalists see task motivation as most important in CL, and they have the view that all CL processes are driven by motivation. Cooperative incentives should therefore ensure that group members can only be successful if the group is successful. Therefore, according to the motivationalist perspective, group goals or group rewards will only enhance the achievement outcomes of CL “if the group rewards are based on the individual learning of all group members” (Slavin, 2013:181). As an example, a group score can be calculated as the average scores of the individual assignments of the group members. The only way the group can therefore succeed is to ensure that individual group members perform and encourage group members to explain to each other, help each other, and encourage each other to achieve. Slavin (2013:181) further expresses the concern that when group rewards are based on a single worksheet or assignment, one member may end up doing all the work, as there is little incentive for group members to explain to each other.

According to the social interdependence theory, learning processes in educational situations can either be based on cooperation or competition between learners or on working individually (Johnson & Johnson, 2017:284). When working cooperatively, social interdependence is seen as positive if individuals perceive that they can only reach their goals if other group members also reach their goals (Johnson & Johnson, 2017:286). When working competitively, social interdependence is seen as negative if individuals perceive that they can only reach their goals if others fail to achieve their goals (Johnson & Johnson, 2017:286). When working individually,

no social interdependence exists, where individuals perceive that they can reach their goals regardless of the performance of other individuals (Johnson & Johnson, 2017:286).

Therefore, working cooperatively, and thus learning cooperatively, is viewed as most appropriate to foster positive interdependence. According to Jolliffe and Snaith (2017:307), the social interdependence theory identifies the need for learners to be mutually dependent and to be accountable for their own work. Although this may seem similar to the motivationalist perspective, a definite difference exists. According to Slavin (2013:182), motivationalists have the view that students help their group mates learn “because it is in their own interests to do so”, while the social interdependence theory states that “group mates learn because they care about the group”.

The cognitive-developmental theory and the cognitive elaboration theory, as described by Slavin (2013:184), have a common cognitive perspective, namely that interactions among group members will increase student achievement, due to mental processing of information. The cognitive-developmental perspective agrees with the theory of the zone of proximal development, as described in section 2.3.2, namely that interaction among peers around tasks will increase mastery of the tasks among the individuals in the group. Opportunities to discuss, to argue, to present, and to hear the views of others are critical elements of CL in view of the cognitive-developmental perspective (Slavin, 2013:184).

According to the view of the cognitive elaboration perspective, a student must engage in a form of cognitive restructuring, or elaboration, of the learning material, for example explaining the material to someone (Slavin, 2013:185). Studies have consistently indicated that students who provide elaborate explanations to others gained the most from cooperative activities, and even students that received explanations from their peers learnt more than those who worked individually (Slavin, 2013:185). Such research provides a strong argument against the concern of Janssen *et al.* (2010:150) that the extraneous cognitive load of students working in groups who provide explanations may become too high (see section 2.3.1.3).

In this section four theories that provide views on the achievement effect of CL were discussed. The first two theories can be described as focusing on the cooperation of groups, and the second two cognitive theories can be described as focusing on the cognitive processing of information due to group interaction. In the following section a refined discussion of CL will be given, focusing on structuring cooperative learning according to five specific elements.

2.4.1.1 *The five elements of cooperative learning*

Johnson and Johnson (2017:286) structured learning processes for cooperation according to the social interdependence theory in such a way as to foster positive interdependence (Johnson

& Johnson, 2017:286). They suggest that the focus should be “on the process by which teaching is conducted, rather than on the content being taught”, which implies that results will be determined by the processes that individuals engage in, and not so much by the goals themselves (Johnson & Johnson, 2017:285). While Slavin (2013:189), from a motivationalist view, places great emphasis on including group goals and individual accountability in CL, Johnson and Johnson (2017:284) suggest that five elements need to be incorporated to make cooperation work, namely positive interdependence, individual accountability, promotive interaction, social skills, and group processing. Although this structuring of CL has been done from a social interdependence view, aspects from the CLT and the SCT, as described above, can be found embedded in these five elements.

In view of the inclusion of the five elements, CL can be defined as a teaching-learning strategy incorporating five specific elements, where small groups of students work together to maximise their own and each other's learning and accomplish a common goal (Johnson & Johnson, 2017:284). This view of CL has become a general standard of implementation in education (Baloche & Brody, 2017:276), and it is the most widely used view of CL (Felder & Brent, 2007:35). In this section the five elements incorporated in CL will be elaborated on.

2.4.1.1.1 Positive interdependence

According to Johnson and Johnson (2017:286), positive interdependence should promote mutual help and assistance between group members, leading to desired outcomes. Positive interdependence is seen by Johnson *et al.* (2008:1:14) as the most important of the five elements. Group members should feel responsible for each other's success, in the sense that one cannot succeed if the other does not succeed. According to Johnson and Johnson (2017:286), positive interdependence can be structured by goal interdependence, joint rewards, divided resources, complementary roles, a shared identity, and task interdependence (Bertucci *et al.*, 2016:97). Individuals should have the view that the work they are doing mutually benefits each other (Johnson & Johnson, 2017:286). In this regard, the view of the motivationalists can also be mentioned, where group rewards are based on the individual learning of group members, and therefore individual learning can be seen to mutually benefit each other. According to Gillies (2014:129), research has consistently indicated that group members that are interdependently linked together are more willing to work together on their mutual goals, and that they achieve higher learning outcomes. The state of positive interdependence between group members will thus create the momentum for members to work together, while they encourage each other to complete their part of the task (Gillies, 2014:130).

Several forms of interdependence in groups are described in the literature. Role interdependence can be achieved when group members are allocated roles to foster positive

interdependence (Felder & Brent, 2007:41; Johnson & Johnson, 2014:842). Individuals can, for example, be required to perform the roles of checker, recorder, and observer in their groups (Slavin, 2013:183). When group members have different roles, they work on different tasks that are appropriately interrelated, and members are expected to accomplish different things, but with one purpose in mind, namely to achieve the group's goals (Johnson & Johnson, 2014:842). Roles can either be assigned formally by the facilitator or assigned spontaneously, where individuals drift into roles based on their interest and skills. A suggestion is that roles should be complementary, meaning that one role cannot be performed without the other (Johnson & Johnson, 2014:842).

Task interdependence exists when a task is divided into subtasks, which need to be completed as allocated to group members. The group can only achieve its goal if all members complete their individual subtasks (Bertucci *et al.*, 2016:97). One example is the jigsaw method, where students have to switch between different groups, while acting as expert teachers and novice students (Berger & Hänze, 2015:295). Learning content is divided into different parts, and a different part is allocated to each group member, resulting in each group member being accountable for a unique part of the learning material (Berger & Hänze, 2015:295). Each group member is then required to study the allocated part of the content and then meet in another expert group, where all members of that group had to study the same content. Group members then return to their original groups, where they have to present their part of the content to the group (Slavin, 2013:182), acting as expert teachers or listening to other students presenting their content, in this case acting as novice students.

Task interdependence can also be fostered by increasing the cognitive level of tasks. According to Pai *et al.* (2015:81), task structure is not the only factor that affects collaboration, but the nature of the task also has an influence on collaboration (Pai *et al.*, 2015:81; Slavin, 2013:190). A number of studies have indicated that when working on simple tasks, group learning will not necessarily be more efficient than individual learning (Kirschner *et al.*, 2011:615; Pai *et al.*, 2015:79). However, with regard to complex learning tasks, which have a high intrinsic cognitive load, research has shown that various forms of collaborative learning are superior to individual learning (Johnson & Johnson, 2017:287; Kirschner *et al.*, 2011:622; Slavin, 2013:190). Complex tasks are thus said to increase the interdependence between group members, because group members need to rely more on each other to solve the task at hand (Kirschner *et al.*, 2011:622).

Goal interdependence can be attained by assigning a goal to the group. The goal of the group could, for example, be that all members have to learn the assigned material (Bertucci *et al.*, 2016:99). Another goal could be that the group needs to collect a certain number of points for an assignment (Bertucci *et al.*, 2016:99). Yet another goal could be the earning of bonus points

on tests by all members of a team with an average assignment grade above a certain percentage (Felder & Brent, 2007:41). When linking the bonus points to the team average, it gives all members an incentive to get the best grade they can, and to teach each other, without putting too much pressure on weaker members, who may not be able to obtain a certain percentage (Felder & Brent, 2007:41).

Cooperative controversy has the cooperative group goal of reaching consensus on issues that individuals disagree on, by synthesising the arguments from different sides (Johnson & Johnson, 2014:842). Heterogeneous groups of four members are randomly assigned by the facilitator, and each group receives a controversial issue to discuss and report on. The groups are subdivided into two members, with each group taking a different stand on the issue. Each small group then has to defend their stand and collect supporting arguments. The small groups merge again into their original groups of four members and listen to and discuss each other's arguments in order to reach consensus and write up a group report, supporting their final stand (Johnson & Johnson, 2014:842).

The combination of task interdependence and goal interdependence has shown important findings regarding achievement and peer support. Research by Bertucci *et al.* (2016:103) has indicated that task interdependence should be combined with goal interdependence for higher achievement and greater peer academic support. Without combining task interdependence with goal interdependence, the potential positive effects of task interdependence may be lost (Bertucci *et al.*, 2016:103).

2.4.1.1.2 Individual accountability

Individual accountability refers to each individual's responsibility to be accountable and perform individually (Felder & Brent, 2007:35; Johnson *et al.*, 2008:1:14). Individual accountability can be seen as one of the main differences between CL and other forms of collaborative groups, resulting in CL being more effective (Bertucci *et al.*, 2016:103; Felder & Brent, 2007:36; Slavin, 2013:187). Each group member should accept the responsibility to complete their part of the task (Gillies, 2014:130) and to master the material that has to be learnt (Felder & Brent, 2007:35).

Many suggestions can be found in the literature for fostering individual accountability in groups. Johnson and Johnson (2017:286) suggest that the effort and the performance of each group member should be assessed, and that feedback on results should be given to individuals and the group in order for group members to account for their share of the work. Felder and Brent (2007:36) offer the following suggestions for fostering individual accountability. Each team member's grade can, for example, be adjusted according to the average of the grades of all

team members. Another means of fostering individual accountability is to use a combination of group assignments and individual assignments. When requiring group members to report back on the group task, the facilitator should be able to ask any group member immediately before reporting is to be done. This method will ensure that each member of the group should be able to report on what the group did, thereby fostering individual accountability and positive interdependence (Felder & Brent, 2007:41).

2.4.1.1.3 Face-to-face promotive interaction

In the 21st century, the increasing use and popularity of social networks and online relationships have posed a new challenge for face-to-face communication (Johnson & Johnson, 2014:849). Research indicates that face-to-face communication remains the most valuable form of communication for groups to be effective, as it requires engagement, energy, focus, and attention (Johnson & Johnson, 2014:849).

Promotive interaction requires that members share resources and encourage each other, by supporting and critically evaluating each other's learning efforts (Johnson *et al.*, 2008:1:14). This should be done by listening to each other, providing constructive feedback, exchanging ideas (Gillies, 2014:131), and challenging reasoning and conclusions (Felder & Brent, 2007:35). Promotive interaction will therefore exist when group members praise each other's efforts and assist, teach, support and encourage each other (Felder & Brent, 2007:35; Johnson & Johnson, 2017:286). When teaching learnt concepts and skills to other students, students practise retrieval of knowledge learnt (Halpern & Hakel, 2003:38). Studies have found that when students discussed explanations about problem-solving scenarios, it led to better understanding, and thus to transfer (Zimmerman, 2013:136). According to Halpern and Hakel (2003:38), the more knowledge is retrieved, the more retrievable it becomes, and transfer of knowledge is fostered.

2.4.1.1.4 Social skills

The fourth element, appropriate use of social skills, requires that learners learn and express interpersonal and group or teamwork skills in order to function effectively as a group (Johnson *et al.*, 2008:1:14). The following skills are mentioned for enhancing group interaction: active listening, considering each other's ideas and perspectives, stating ideas clearly without making degrading comments, accepting responsibility for behaviour, constructive critique of ideas, sharing of resources, taking turns (Gillies, 2014:130), and social skills of leadership, decision-making, trust-building, communication, and conflict management (Johnson & Johnson, 2017:286). Social skills are further considered a critical element of CL with regard to problem-solving success, achievement gain, establishing effective working relationships between group members, and fostering metacognition (Gillies, 2014:131).

It is argued by Buchs and Butera (2015:212) that it should not be assumed that learners will have the necessary social skills required to work in cooperative groups, but that a climate should first be created that will foster willingness to cooperate, to ask for help, and to handle conflict. A suggestion is to let learners first reflect on situations involving good examples and counter-examples of the use of social skills (Buchs & Butera, 2015:208), to create a rationale for promoting good social skills. Felder and Brent (2007:42-43) suggest that students can be assisted to develop teamwork skills, by requiring groups to compile and sign a list of policies and expectations, and by giving them tools to handle conflict. Because it usually takes a long time for groups to learn to work through problems, it is further suggested that groups should stay intact for at least a month (Felder & Brent, 2007:42-43). Such a time span is, however, not always feasible, and group members should rather be determined by taking into account the composition of the group, as will be discussed in section 2.4.1.2.

2.4.1.1.5 Group processing

Embedding the fifth and final element, group-processing, means that groups have to reflect on and discuss how well they have achieved their goals, and which behaviours need to change in order to improve the group's performance (Johnson *et al.*, 2008:1:14-1:15). Group members are expected to show appreciation and respect for each other's contributions, which tends to increase members' self-esteem (Johnson & Johnson, 2009:370). When engaging in group processing and receiving feedback, group members are being made more aware of their thinking about the topic being discussed, and they are provided with insight into how to behave more effectively and how to improve their social skills when interacting with others (Gillies, 2014:131). When giving feedback skilfully, the focus is directed towards constructive action, and group members are empowered to be more effective in future (Johnson *et al.*, 2008:7:5).

Group processing can be either facilitator-led or student-led. Group members can, for example, be asked to discuss which actions of group members have contributed to the achievement of all group members and the maintaining of effective working relationships (Johnson & Johnson, 2017:286), what they have been doing well, what needs improvement, and what they will do differently next time (Felder & Brent, 2007:43).

Because group processing is seen as the final phase of a cooperative learning lesson, it can easily be neglected due to time constraints or insufficient planning. This final element is, however, of equal importance in relation to the other elements, and the full benefits of cooperative learning will not be reaped if this element is left out. Research has shown that including group processing in cooperative learning leads to higher achievement, better relationships between group members, and less social loafing (Johnson & Johnson, 2009:369).

Even when the group has not performed satisfactorily, learning can still take place when reflecting on the group's performance.

Apart from group processing, some researchers have argued that in certain circumstances not all of the other elements need to be included for groups to function cooperatively. According to Slavin (2013:190), when groups are required to do higher-level cognitive tasks, solve complex problems, or do controversial tasks with multiple answers, all of the above elements need not be included in CL groups, as the nature of the tasks in itself will lead to effective group processing. Felder and Brent (2007:43), however, state that CL will work even better if students are faced with complex tasks and challenging problems, as students normally resent working in groups on easy tasks that they could have completed on their own. Although resistance from students can be expected at first when implementing CL (Buchs & Butera, 2015:211; Felder & Brent, 2007:44), this can be overcome when CL is implemented appropriately, and it will be minimised once students experience the benefits of CL. The standpoint in this thesis is that CL is implemented appropriately when all five elements as suggested by Johnson and Johnson (2017:284) are incorporated. Groups will thus function even better when incorporating all elements when complex tasks have to be processed.

As indicated above, a vast amount of research agrees on the positive effects of CL on learning and developing competencies. It can therefore be concluded that when structuring CL according to the five elements mentioned above, optimal learning, development of competencies, preparation of students for professional careers (Felder & Brent, 2007:44), and transfer of knowledge and competencies can be accomplished.

Apart from designing and structuring CL to include the five elements as discussed above, the composition of groups should also be attended to, as the composition of the group can also influence the effectiveness of the group.

2.4.1.2 *The composition of groups*

Three aspects of groups that should be considered when determining groups in CL are the number of group members, the diversity of the group, and the time span that the group will exist (Johnson & Johnson, 2014:850). Regarding the number of group members, the literature suggests that four or fewer members are preferred (Gillies, 2014:133; Johnson & Johnson, 2014:842). Slavin (2013:186) suggests rather working in pairs, as groups of four may first need time to develop strategies for working together. Felder and Brent (2007:40), however, argue that pairs might be lacking in diversity of ideas, and they suggest that groups of three or four should rather be formed for most tasks. Johnson and Johnson (2013:484) suggest that groups should be kept as small as possible. It therefore seems that a general guideline for group size is four or

fewer members. However, depending on the purpose of the group, the task to be accomplished, and the diversity of ideas needed, groups should be kept as small as possible.

It is further suggested by Felder and Brent (2007:40) that group members should be allocated by the facilitator, as students usually select their friends or popular classmates and leave other students out. It is thus not a preferred practice for students to select their own groups. Students have to be prepared for the real world when working in teams in real life, where they will probably not be able to choose their teammates (Felder & Brent, 2007:40).

The diversity of the group can be described as determining how group members will be assigned, that is, homogeneously or heterogeneously. Johnson and Johnson (2013:446) describe three sources of diversity: demographic, for example age, gender and ethnic differences; differences in abilities or skills, which can be social or technical; and differences in personality characteristics. They, however, also mention that no group can be considered truly homogeneous, as there will always be differences between individuals (Johnson & Johnson, 2013:454). Although arguments can be made against heterogeneous groups, it seems that the research favours such groups (Gillies, 2014:133; Johnson & Johnson, 2013:453; Zhang *et al.*, 2016:171).

Heterogeneous groups are more likely to perform better in problem-solving, creativity, and decision-making, because of the range of skills, knowledge, and perspectives that is available (Johnson & Johnson, 2013:450-451). Weaker students will gain from seeing how other students approach problems, and stronger students will gain a deeper understanding when teaching other students and being asked questions by others, requiring them to evaluate their own understanding (Felder & Brent, 2007:40). Although challenges exist within heterogeneous groups, Johnson and Johnson (2013:454) argue that the promise of diversity outweighs the problems, as long as group members value diversity and understand how to avoid pitfalls and capitalise on benefits. Diverse personalities can be united by incorporating a high level of positive interdependence, creating mutual goals, developing common ground, and creating a group identity (Johnson & Johnson, 2013:469). Accordingly, an effective way to assign students to a group is by using a random method (Johnson & Johnson, 2013:486). Creative group allocation can be seen as an icebreaker and as providing common ground for heterogeneous groups, for example by asking students to write down their favourite sports team or vegetable, and then asking them to find students who have the same preference (Johnson & Johnson, 2013:469).

The time span that groups exist for relates to the type of cooperative learning that is required. Cooperative learning is classified as formal CL, informal CL, and cooperative base groups

(Johnson & Johnson, 2014:841). These types can also be described according to the types of groups working together on mutual goals, namely formal CL groups, informal CL groups, and cooperative base groups (Johnson & Johnson, 2017:292). The types of groups are distinguished by the time span that the groups work together and the purpose of the groups. Formal CL groups work together for one or several sessions, in order to master certain content (Johnson & Johnson, 2017:292). With formal CL groups, allocation of the group members and the roles of the group members have to be carefully planned by the facilitator, and assignments have to be carefully designed by the facilitator (Johnson & Johnson, 2017:292).

Informal CL groups engage in discussions that range in length from a few minutes to one class session (Johnson & Johnson, 2017:292). The purpose of these groups is to ensure active cognitive processing of learning content (Johnson & Johnson, 2014:841), by focusing on specific learning material, creating a mood conducive to learning, creating expectations for learning, or summarising learning content (Johnson & Johnson, 2017:292). Group members are allocated informally by the facilitator, for example requesting that individuals sit next to each other to work together (Johnson & Johnson, 2017:292). By contrast, cooperative base groups have long-term and stable group membership, for example for the duration of the course. The function of cooperative base groups differs from that of other types of groups, as group members in cooperative base groups have to support each other academically and socially in order to complete the course successfully, by, for example, encouraging each other to attend class and to complete assignments (Johnson & Johnson, 2017:292).

Johnson and Johnson (2014:842) advise that constructive controversy be used in combination with the other three types of CL groups. During constructive controversy deliberate discourse scenarios are created, to encourage group members to disagree and elaborate on arguments, to ultimately reach agreement or a decision (Johnson & Johnson, 2014:842). Several outcomes of controversy are listed, with creativity mentioned as having a “strong” connection with controversy (Johnson & Johnson, 2013:320). Johnson and Johnson (2013:319) conclude that controversy tends to foster creative insight, as students have the opportunity to view problems from various perspectives, and they can then reformulate problems, which contributes to novel solutions. Accordingly, Popov *et al.* (2017:426) point out the benefits of learning when group members engage in discourse, critique and challenge each other’s views, and are able to come to mutual agreement. Controversy has also been indicated as improving transfer to new situations (Johnson & Johnson, 2013:318). In relation to concurrence seeking, debates, or individualistic efforts, constructive controversy has indicated higher reasoning levels and metacognition, improved motivation to learn about the issue at hand, improved interpersonal

attraction, and social support and social competence among participants (Johnson & Johnson, 2013:320-323).

2.4.1.3 Cooperative pair programming

Pair programming entails that two computer programmers work together side by side on one computer and collaborate to solve a problem (Williams & Kessler, 2003:3). According to Wray (2010:50), Williams and Kessler (2003) originally described the roles of the pair as “driver” and “navigator”. These roles will accordingly be described as envisaged by Williams and Kessler (2003:3). The driver has to operate the computer, type in commands, or write a design. The navigator is described as the “strategic, long-range thinker”, who asks the driver questions, for example to explain what they are doing (Williams & Kessler, 2003:3). The navigator also has many other tasks, including checking for errors, observing what the driver is doing, and asking appropriate questions to ensure that the driver is on the right path. The driver and the navigator can also at any time engage in brainstorming activities (Williams & Kessler, 2003:3). During their problem-solving activity, the driver and the navigator will from time to time swap roles (Wray, 2010:50).

One of the reasons that pair programming can be considered an effective strategy to understand and solve problems is called the “rubber-plant effect” (Sturdy, 2005:223). According to Sturdy (2005:223), “conflicts in the thoughts” can often be resolved by expressing thoughts in language. The interaction between the driver and the navigator, in the form of “back-and-forth chat”, thus continuously triggers each other’s thoughts and assists in solving problems (Wray, 2010:51).

Pair programming is indicated as an effective strategy for teaching and learning programming skills (Mentz *et al.*, 2008:259; Plonka *et al.*, 2015:77). Mentz *et al.* (2008:247) indicated that pair programming will be more effective and groups will perform better when the five elements of CL are embedded in pair programming. In these conditions, pair programming has also been shown to positively influence learners’ critical thinking skills (Bailey & Mentz, 2017:102). For the remainder of this thesis, it will be referred to as “cooperative pair programming”.

In this section CL and cooperative pair programming as teaching-learning strategies, have been defined and explained. Theories on which CL are based were discussed, and the five elements that need to be incorporated, as well as the composition of groups, were elaborated on. To further provide a rationale for using CL to foster DL, it will be shown how CL can contribute to cognitive, intrapersonal and interpersonal competencies as required for DL.

2.4.2 Cognitive, intrapersonal and interpersonal competencies as outcomes of cooperative learning

A vast amount of research pertaining to different age groups and disciplines supports CL across a diverse range of outcomes (Felder & Brent, 2007:39; Gillies, 2014:127; Johnson & Johnson, 2014:843; Pierce, 2015:9). According to Johnson and Johnson (2014:843), the results of over 685 studies express effect sizes showing the strength of relationships between social interdependence and achievement. Results of studies consistently indicate that in comparison to individual and competitive learning, CL promotes higher achievement and productivity (Gillies, 2014:128; Johnson & Johnson, 2014:843). According to Sharan (2010:300), CL combines and promotes academic and social skills. Research also constantly associates CL with cognitive, intrapersonal and interpersonal competencies (Johnson & Johnson, 2015:41). Among these competencies, Bolhuis (2003:331) specifically mentions that CL as a social learning strategy enhances learning and promotes self-esteem, self-regulation, reflection, and cognitive conflict. According to Plonka *et al.* (2015:77), when engaging in pair programming, even experts regard sessions in which novices ask them questions as rewarding, as it helps them “to reflect on their own practices and thus learn from the experience”.

Sharan (2010:303) states that various CL methods have been found to foster a variety of skills, such as mastery of knowledge, intrinsic motivation, social skills, and interpersonal communication, placing the value of CL in all three categories of DL competencies. Johnson and Johnson (2014:842) also confirm that all outcomes of CL can be placed within three broad categories: effort to achieve, positive psychological adjustment, and interpersonal relationships. These categories can, in turn, be linked to the cognitive, intrapersonal and interpersonal competencies associated with DL. In the following discussion the outcomes of CL will accordingly be mapped to the 21st-century competencies (see Table 1.1), namely cognitive (effort to achieve), intrapersonal (psychological adjustment) and interpersonal (interpersonal relationships) competencies.

2.4.2.1 Cognitive competencies fostered with cooperative learning

Regarding the cognitive domain, research has indicated that cooperative learning has meaningful impact above competitive or individualistic efforts (Felder & Brent, 2007:39). Cognitive competencies that can be mentioned are academic performance (Yamarik, 2007:275), learning satisfaction and learning gain in higher-order thinking, learning and reasoning (Johnson & Johnson, 2017:287; Tadesse & Gillies, 2015:12), problem-solving and retention of knowledge (Gillies, 2014:127; Johnson & Johnson, 2017:287; Zou & Mickleborough, 2015:157), critical thinking (Bailey & Mentz, 2015:150; Garcha & Kumar, 2015:61; Johnson & Johnson, 2017:288; Malatji, 2016:34), and transfer of learning (Felder & Brent, 2007:39;

Johnson & Johnson, 2017:287). The advantages of cooperative pair programming when problem-solving, described as the “rubber-plant effect” (Sturdy, 2005:223), have also already been discussed in section 2.4.1.3.

According to Ellis *et al.* (2018:10), when students are collaborating in a productive environment, “deep approaches to inquiry and learning” have been noted. Kyndt *et al.* (2013:143) did a meta-analysis on the effects of face-to-face CL, and they found that CL has the most positive effect on achievement in formal learning settings. It should further be noted that the more cognitively demanding a task is, the more the above-mentioned cognitive competencies seem to be realised and developed when CL as a teaching-learning strategy is used (Johnson & Johnson, 2014:843). When teaching each other in a group, learners need to cognitively restructure the information in order to explain to others and therefore receive a cognitive benefit, with the additional explanation also benefiting the learner who is being explained to (Damon, 1984:339; Slavin, 2013:184).

Cognitive benefits of CL can also be described in view of the CLT (Berger & Hänze, 2015:310). Groups are seen as “information-processing systems”, in that cognitive effort is distributed among group members (see Figure 2.5). As discussed in section 2.3.1.3, concerns have been raised that working in groups will place an additional extraneous cognitive load on students (Berger & Hänze, 2015:310; Janssen *et al.*, 2010:145). The five elements that need to be included in CL address the concerns raised in the literature and the conditions set in view of the CLT, as mentioned in section 2.3.1.3. Positive interdependence needs to be fostered in CL groups (see section 2.4.1.1.1). Group members then become dependent on each other. Roles are allocated to group members, and less planning of transactive activities is required, because of the structure of CL.

Complex tasks were also mentioned as a prerequisite for groups to function optimally (see section 2.3.1.3) from a CLT view. According to Johnson and Johnson (2017:287), the superiority of CL increases as tasks become more cognitively demanding. It is also suggested that group size should be kept small – not more than four members (see section 2.4.1.2). Although concerns have been raised that a higher extraneous cognitive load is exerted upon high-ability students when they explain to students with less prior knowledge, Plonka *et al.* (2015:77) indicated that experts often find it beneficial to their learning when they explain to novices in pair programming environments (see section 2.4.1.3). It is therefore argued that the structured nature of CL, where the five key elements are incorporated (see section 2.4.1.1), will reduce the extraneous cognitive load, allocating more memory to germane resources, thus enhancing learning and fostering transfer.

2.4.2.2 *Intrapersonal competencies fostered with cooperative learning*

According to Johnson and Johnson (2014:843), working cooperatively with peers results in higher self-esteem and psychological health than competing with peers or working independently. The more individuals work together cooperatively, the more it impacts on the intrapersonal domain, by valuing difference and fostering respect for others (Damon, 1984:335). Individuals will thus become more aware of their own value and worth (Johnson & Johnson, 2014:843), they will develop better self-esteem, they will be more motivated (Gillies, 2015:3), and they will develop positive attitudes towards learning (Felder & Brent, 2007:39; Johnson & Johnson, 2015:27; Yamarik, 2007:275). Learners who work together will accordingly have more confidence in their abilities to solve a task, which will positively influence the efficacy of the group – the group's motivational commitment to their task, and their belief in their ability to succeed.

According to Felder and Brent (2007:39), studies have also indicated that CL is superior for promoting metacognitive thought and persistence in working towards a goal. Especially during the element of group processing the group reflect on their failure or success, developing members' metacognition and promoting individual self-monitoring (Johnson & Johnson, 2013:108). As the above-mentioned intrapersonal competencies improve, individuals become more productive, independent and autonomous (Johnson & Johnson, 2014:843).

Although CL has been indicated as fostering metacognition, as described above, specific metacognitive instruction within CL can further enhance metacognitive learning (Veenman *et al.*, 2006:9). According to Veenman *et al.* (2006:9), the literature suggests the following principles to improve metacognition: embed metacognitive instruction in content matter; inform learners about the usefulness of metacognitive activities; and continuously include metacognitive activities. In this regard, Breed *et al.* (2013:52) found that metacognitive awareness of learners involved in pair programming could be enhanced by incorporating metacognitive strategies.

2.4.2.3 *Interpersonal competencies fostered with cooperative learning*

According to Pai *et al.* (2015:82), results of studies on collaborative learning have indicated that social interaction inhibited students from retrieving ideas, and that students also withheld ideas out of fear of criticism. However, because CL focuses on positive interdependence and a social way of learning (Johnson & Johnson, 2015:24-25), it is naturally consistent with the interpersonal domain of the 21st-century competencies of teamwork, collaboration, and leadership (Pierce, 2015:10), and the development of interpersonal skills, attitudes and behaviours, and communication skills (Gillies, 2014:127; Johnson & Johnson, 2017:286). In comparison to students involved in competitive or individualistic learning environments, it can be stated that cooperatively taught students present better social skills (Felder & Brent, 2007:39).

When working cooperatively, students care more about each other and are more committed to each other's success and well-being. In the process they form personal and professional relationships and master social competencies (Johnson & Johnson, 2014:843).

In this section a rationale was presented for choosing CL as a teaching-learning strategy to foster cognitive, intrapersonal and interpersonal competencies. These competencies influence each other in both directions – the more students care about each other, the harder they work to achieve learning goals, and the more confidence they obtain in their own competencies (Johnson & Johnson, 2014:843). In the following section research on the impact of CL on transfer of learning will be discussed.

2.4.3 Cooperative learning and transfer of learning

When looking at the effect of CL on transfer of learning, the picture of the supporting literature looks different from the literature on supporting the effect of CL on effective learning. A meta-analysis done by Pai *et al.* (2015:79) indicated that group learning has a potential benefit on transfer. Although research indicates that CL contributes to improved transfer (Felder & Brent, 2007:39; Johnson & Johnson, 2017:287), Pai *et al.* (2015:79) question if CL specifically had a greater benefit on transfer than unstructured small-group learning. However, according to Plonka *et al.* (2015:75), the positive effect of pair programming on knowledge transfer has been widely acknowledged. It can thus also be stated that cooperative pair programming (see section 2.4.1.3) can also be suggested as a teaching strategy to foster transfer.

Reference must also be made to research by Grossman and Burke-Smalley (2018:234) regarding transfer. One of the elements of CL that distinguishes CL from merely working in groups is individual accountability (see section 2.4.1.1.2). Interestingly, research suggests that transfer of training can be improved when targeting accountability (Burke & Saks, 2009:397; Grossman & Burke-Smalley, 2018:234). This research therefore also suggests that transfer can be improved with CL.

Research by Kirschner *et al.* (2009b:311-312) indicated that group learners performed more efficiently on transfer tasks than individual learners, although the individual learners performed better on retention tests. It was thus possible for group members to more deeply process information elements and relate concepts (Kirschner *et al.*, 2009b:311-312). Research by Schwartz (1995) indicated that group members have to negotiate their multiple perspectives to a common representation, which will thus be an abstract representation that bridges the different individual views of group members (Pai *et al.*, 2015:82) and will therefore facilitate transfer. Individuals, however, had to focus more on remembering the information, which hindered them in relating concepts, and thus in their transfer of learning (Kirschner *et al.*,

2009b:312). It should be noted that this research was not specifically related to CL groups, and that specific research results comparing the transfer benefits of unstructured small groups with those of CL groups could not be found.

According to Pai *et al.* (2015:82), one of the unique benefits of collaboration is the ability to promote deep understanding, or transfer. Transfer of learning gain specifically with regard to CL is mentioned by Johnson and Johnson (2014:843) as greater transfer – from one situation to another, individual and group transfer, as well as application of what has been learnt. Therefore, given the profound effect of CL on learning (Gillies, 2014:129), the benefits of CL on transfer, and the discussion above relating to the fostering of cognitive, intrapersonal and interpersonal competencies, it is hypothesised that deeper learning can be developed by using cooperative learning as a teaching-learning strategy.

2.5 CONCLUSION

In this chapter DL was defined, and an attempt was made to provide a theoretical basis for DL, by discussing cognitive load theory and social constructivist theory. Transfer of knowledge as an outcome of deeper learning was discussed, by discussing some views of transfer, research on transfer, and teaching-learning strategies that can improve transfer. Finally, cooperative learning, and also in the form of cooperative pair programming, was motivated as a teaching-learning strategy to foster DL. In the following chapter self-directed learning will be discussed, and a theory for deeper self-directed learning will be proposed.

CHAPTER 3:

PROPOSING A THEORY FOR DEEPER SELF-DIRECTED LEARNING

3.1 RATIONALE

According to Guglielmino (2013:2-3), in order to prepare learners for an exponentially changing world of knowledge, technology, and globalisation, and to embrace the challenges of the 21st century (see section 2.1), it is essential to develop learners' full potential as self-directed learners. In the previous chapter a theoretical basis for deeper learning (DL) was provided. In this chapter self-directed learning (SDL) will be elaborated on, in order to provide a theoretical foundation for deeper self-directed learning (DSDL). It is accordingly argued that to successfully face the challenges of the 21st century, it is not sufficient to only be self-directed learners; the aim should also be on fostering DSDL. Thus, while developing students' SDL, the focus should also be on developing DL.

In this chapter, SDL will be defined, and characteristics or attributes of self-directed learners and outcomes of being a self-directed learner will be discussed. The role of the educator in developing students' self-directed learning will also be explained. Thereafter, integration of SDL in deeper learning will be motivated and discussed, to provide a theoretical argument for DSDL. Lastly, it will be argued that cooperative learning as a teaching-learning strategy can be conducive to developing DSDL.

3.2 DEFINING SELF-DIRECTED LEARNING

The concept of SDL emerged from studies on adult learning in the 1960s (Merriam *et al.*, 2007:105; Williamson, 2007:66). Tough's (Tough, 1971) and Knowles' (Knowles, 1975) research on adult education and their portrayal of SDL prompted a vast and ever-growing body of research on SDL, which had a ripple effect on numerous educational landscapes (Conner *et al.*, 2009:62; Gavriel, 2015:3; Merriam *et al.*, 2007:105). SDL is regarded as one of the most-researched educational areas (Guglielmino, 2013:2), and research in this area has since been expanded from adult education to all ages and levels of education (Merriam *et al.*, 2007:107). According to Merriam *et al.* (2007:106), early research on SDL was mostly descriptive. The focus initially was on confirming that adults deliberately learn on their own, and on providing an explanation of how they go about it (Merriam *et al.*, 2007:106). In 1975 a publication by Knowles on SDL was released, second only to Tough (1971), which is regarded as the most-cited publication on SDL (Conner *et al.*, 2009:62; Guglielmino, 2013:2).

Knowles (1975:18) defined SDL as follows:

In its broadest meaning, “self-directed learning” describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material sources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes.

Since Knowles (1975), numerous attempts have been made to define and describe SDL (Long, 2000:11). Some authors have divergent and inconsistent views on SDL (Bolhuis, 2003:327; Candy, 1991:6; Dehnad *et al.*, 2014:5184; Francom, 2010:31). De Beer and Gravett (2017:37) accordingly argue that the term “self-direction” as applied to learning is often used in different and confusing ways. Timmins (2008:303), for example, mentions that SDL can be seen as “an additional extra” or as a “teaching/learning method”, which indicates how SDL can be applied to organise instruction (Candy, 1991:7). Such divergent views on SDL can be attributed to the two-part nature of the term “SDL”, which refers to *self-direction* and *learning*, which can be done both individually and in relation to others, and hence the term “SDL” is defined and interpreted in numerous ways (Candy, 1991:5; Long, 2000:12).

According to Long (2000:13), self-direction refers to the conscious controlling of a process by an individual. He views learning as a combination of psychological and neurological processes, resulting in changes on psychological and physical levels in individuals (Long, 2000:12-13). He further views SDL similarly to Knowles regarding the use of resources and the learner’s responsibility. Although many views on SDL exist, the view and interpretation of SDL that will be used in this thesis will be based on Knowles’ definition (Knowles, 1975:18).

Although Knowles (1975:18) defined SDL as a process, SDL has also been studied from other perspectives based on Knowles’ definition. Examples of such perspectives are SDL in view of learner characteristics or personal attributes, and SDL in view of the aims or outcomes of SDL (Candy, 1991:6; Merriam *et al.*, 2007:106). Accordingly, some research relating to these views will be discussed.

3.2.1 Characteristics and attributes of self-directed learners

It is widely accepted that self-directed learners can be identified by certain individual qualities, attributes or characteristics. Knowles (1975:21) states that self-directed learners are intrinsically motivated, and that they are therefore characterised by a desire to achieve, an urge to advance or develop themselves, curiosity, and a need to know specific things. According to Guglielmino (2013:2), when focusing on SDL in view of personal characteristics, her 1978 study is regarded as the most operational study.

Based on Guglielmino (1978), other researchers also describe self-directed learners by referring to their characteristics (Candy, 1991:7). Williamson (2007:66) describes self-directed learners as being proactive in their learning. Dehnad *et al.* (2014:5186) state that self-directed learners should be responsible for their own learning and management of their learning processes. According to Kell and Van Deursen (2002:32), self-directed learners display initiative, independence, self-confidence, persistence, and excellent time management skills, view “problems as challenges”, are “skilled in critical thinking”, and are “comfortable with uncertainty and change”.

Other characteristics of highly self-directed learners, as determined by Guglielmino (1978:73), are that they have a strong desire to learn or change, they display self-discipline, they can pace their learning appropriately by applying good time management and planning, they enjoy learning, and they are goal-oriented. Guglielmino (2013:9) adds that a high level of SDL readiness is associated with creativity and problem-solving abilities.

3.2.2 Outcomes of enhancing self-directed learning

As indicated by Merriam *et al.* (2007:106), SDL can also be studied in terms of the outcomes of SDL. Thus, during the process of fostering SDL, apart from fostering SDL characteristics in learners, educators are also striving to achieve various aims or outcomes. Before discussing these outcomes, it is, however, first necessary to attempt an explanation of what is meant by defining SDL as a process (Knowles, 1975:18).

According to the Cambridge Dictionary, a process can be defined as a “series of actions” that an individual takes in order to achieve a result, or “a method of producing goods in a factory” (Cambridge University Press, 2018). Knowles elaborates on the view of SDL as a process, by stating that teaching with an SDL approach assumes that the learner “grows in capacity to be self-directing”, and that “this capacity should be nurtured to develop as rapidly as possible” (Knowles, 1975:20).

According to Candy (1991:424), SDL is “simultaneously a process and a product”. Candy describes the product of SDL as the responsibility to take a lifelong initiative in learning. To Knowles the product is developing the competence of learning “without being taught” (Knowles, 1975:17). The product of SDL is thus much richer and more comprehensive than merely a production of goods. Learners have their own individual SDL readiness patterns (Knowles, 1975:20), and the product of SDL will be numerous lifelong learning competencies, including characteristics and attributes as described in section 3.2.1.

SDL as a process further has the aim of developing SDL continuously, and it thus has no final product to deliver. Indeed, Candy (1991:424) describes it as “a literal impossibility” that SDL can

deliver a final product. The process of developing SDL is also seen as a series of non-linear actions (Guglielmino, 2013:5), with the aim of achieving a specific result – to continuously develop SDL to increase students' capacity to “conduct their own learning” (Francom, 2010:29). According to Bolhuis (2003:343), process-oriented teaching with self-direction as the aim involves four principles: (1) helping students to gradually acquire competencies; (2) stimulating the process of building knowledge; (3) attending to the emotional aspects of learning, such as fostering motivation; and (4) teaching social skills and fostering collaboration in learning.

Numerous studies have indicated that SDL correlates with academic achievement and attitudes towards learning (Cazan & Schiopca, 2014:641; Edmondson *et al.*, 2012:40; Guglielmino, 2013:8). According to Williamson (2007:66), the learning of self-directed learners will be more meaningful and purposeful and will result in longer retention. This is confirmed by Gureckis and Markant (2012:464), who focus on SDL from a cognitive perspective.

When, however, looking further into the matter of correlating SDL with academic achievement, the issue becomes more complicated. Although it is generally expected that SDL readiness will have a positive correlation with academic achievement, some researchers have found no correlation (Van der Walt, 2014:7). A possible explanation provided by Van der Walt (2014:7) is that students overestimate their self-directed learning readiness in a specific context. Apart from SDL readiness, many other factors can influence academic achievement, for example the difficulty of the learning material (Berger & Hänze, 2015:296), personality factors, the learning context (Cazan & Schiopca, 2014:643), and the type of teaching-learning strategy applied (Markant *et al.*, 2016:142). It is, however, also possible that a learner's self-directedness may be influenced by their competency in specific content (Long, 2005:4). It can thus be hypothesised that a learner's competency, for example in mathematics, language, or database design, can influence the learner's SDL in that specific subject area.

With all the above-mentioned factors in mind, it is deemed necessary to refer to the cognitive load theory (see section 2.3.1) and its implications for SDL. Berger and Hänze (2015:310) found that when teaching content has a high cognitive load, prior knowledge is a significant predictor of academic performance, and the effect of intrinsic motivation and quality teaching becomes less significant. Yang *et al.* (2018:37) also argue that levels of prior knowledge affect students' approach to learning and motivation. Therefore, when taking the cognitive load theory into account, Berger and Hänze (2015:310) argue that difficulty of content reduces the impact of intrinsic motivation, the latter being regarded as crucial for SDL (see section 3.4.1.2). Self-directed learners should therefore have the skills to integrate and connect information in the working memory with information in the long-term memory, in order to develop “deep processing skills” (Long, 2005:3). When such deep processing skills exist, it may consequently foster

enjoyment of learning, changing mindsets to view problems as challenges (Kell & Van Deursen, 2002:32), and setting in motion or fostering the process of SDL. Self-directed learners can thus be described as learners who discover, integrate and apply theories (Candy, 1991:296), as opposed to low self-directed learners, who tend to memorise and reproduce facts (Guglielmino, 2013:5).

In this section SDL has been defined and discussed by looking at the characteristics of self-directed learners, SDL as a process, and the outcomes of enhancing SDL. Before attempting to combine DL and SDL, the role of the educator in fostering SDL environments will first be discussed.

3.3 THE ROLE OF THE EDUCATOR IN FOSTERING SELF-DIRECTED LEARNING ENVIRONMENTS

Each learner possesses some degree of assessable and malleable SDL (Candy, 1991:7; De Beer & Gravett, 2017:37; Guglielmino, 2013:6; Van Deur, 2018:2), and educators therefore play an integral part in assessing and developing SDL (Candy, 1991:7). According to Guglielmino (2013:3), learners' SDL can be assessed by determining their SDL readiness on a continuum, where learners at the lowest level will typically prefer direct instruction. Confirming this, Bellanca and Guglielmino (2014:2) state that SDL does not happen by chance, and that students must therefore be intentionally supported in developing their SDL. The teacher or facilitator should design a format of instruction where learners are able to develop their SDL competency (Knowles, 1975:39) and apply self-direction in learning (Long, 2000:14). Educators are thus seen as responsible for selecting and applying appropriate teaching-learning strategies and designing learning experiences to develop learners' SDL (Bellanca & Guglielmino, 2014:2; Fandiño, 2013:203; Knowles, 1975:39; Van Deur, 2018:3; Williamson, 2007:68), and thus raising learners' SDL level on the SDL readiness continuum.

Fostering and developing SDL therefore requires competent educators who are knowledgeable about SDL and can manage the social teaching-learning environment and learning activities (Long, 2000:15). Guglielmino (2013:2, 5), however, expresses concern that opportunities to foster SDL are rarely created by educators, and that a paradigm shift in this regard is still required.

In the following section suggestions will be given on how educators can foster SDL in learning environments.

3.3.1 Fostering self-directed learning in the classroom

Despite researchers making an impassioned plea to foster SDL in education (see section 3.2), developing SDL is seen as an additional challenge for educators (Guglielmino, 2013:5). This

challenge is additionally burdened by students' notion of teaching. Students who have a low level of SDL are often not familiar with strategies that attempt to improve their SDL (Guglielmino, 2013:10). According to Timmins (2008:302), some students believe that SDL is a convenient cop-out for teachers from their responsibilities, and that students are expected to follow a "do-it-yourself" approach.

Educators should therefore first attend to learners' beliefs about SDL. The notion should be instilled that the traditional role of educators as the presenters of knowledge and the sole resource for learning is evolving to that of educators as facilitators that guide learners into taking responsibility for their own learning (Guglielmino, 2013:4; Knowles, 1975:33; Merriam *et al.*, 2007:125). Learners should accordingly be assisted to diagnose their learning needs, plan, manage, carry out and evaluate their learning, locate and select appropriate resources, and select and apply appropriate learning strategies (Guglielmino, 2013:4; Merriam *et al.*, 2007:107; Wirth, 2007:110).

Stated broadly, fostering SDL in the classroom entails two aspects – creating a climate for SDL (Knowles, 1975:45), and planning classroom activities accordingly (Long, 2000:14). These two aspects will be elaborated on in the following section, and recommendations for strategies to enhance SDL (Guglielmino, 2013:10) will be given.

3.3.1.1 *Creating a climate for self-directed learning*

As indicated above, SDL is mostly an unfamiliar concept for learners, and their expectations regarding teaching can be a barrier to implementation of SDL. In order for learners to agree to and be willing to take on the challenge of SDL, Knowles (1975:45) recommends that learners must be informed about SDL and its purpose, as well as what is expected of them to create the right climate for SDL. Not only should learners' view of teaching change, but teachers should also accordingly view themselves as facilitators, and not as mere transmitters of knowledge (Knowles, 1975:32). This requires that educators will be willing to abdicate their role of authority figures, with all knowledge intact, and thus expose themselves as authentic human beings, with strengths and weaknesses (Knowles, 1975:33).

Gureckis and Markant (2012:464) argue that to enhance SDL, learners should be allowed more control of the content that needs to be studied. Currently, in most learning situations the educator controls the information presented to the learners, as well as the outcomes that have to be achieved. Learners should accordingly be allowed to make decisions to satisfy their individual learning needs, and should be able to choose content and information that they want to access based on what they want to experience (Gureckis & Markant, 2012:465). It is further suggested that by making relatively small changes to learning tasks, described as "self-directed

alternatives”, “dramatic consequences for what is learned and retained” can be achieved (Gureckis & Markant, 2012:465).

According to Knowles (1975:21), the attitude of learners towards teaching and learning is the greatest determining factor of SDL. Teacher-directed classrooms are usually characterised by the giving of rewards, which promotes extrinsic motivation, as opposed to SDL classrooms, where learners’ intrinsic motivation is kindled, so that they can persist, develop resilience and take responsibility for their learning (Guglielmino, 2013:6). SDL thus assumes that “learners are motivated by internal incentives”, such as “the desire to achieve”, “the urge to grow”, the need to know, curiosity, and the “satisfaction of accomplishment” (Knowles, 1975:21).

Educators are urged to create conditions or environments to maintain learners’ intrinsic motivation, as intrinsic motivation can easily be undermined by various factors (Ryan & Deci, 2000b:70). Educators are further challenged to stimulate learners’ intrinsic motivation by identifying and focusing on learners’ interests (Long, 2000:17), keeping in mind that learners will hardly be motivated by unchallenging activities that do not interest them, that have no novel or aesthetic value, and that are posed in uncaring environments (Ryan & Deci, 2000b:71). It should further be noted that the type of motivation, rather than the amount of motivation (Deci & Ryan, 2008:14), is another important factor to consider. Educators need to stimulate learners’ intrinsic motivation, without making use of extrinsic motivation strategies (Deci & Ryan, 2008:14). In section 3.4.1.2.1 motivation will be elaborated on.

Van Deur (2018:4) argues that when learners have appropriate mindsets and believe that they can be self-directed learners, it will positively influence their motivation, and thus the development of their SDL skills. Learners’ mindsets are defined by Dweck (2015:20) as “how they perceive their abilities [or skills]”. According to Yeager and Dweck (2012:303), a growth mindset is a requirement for the application of skills. Even though learners are taught new intellectual or social skills, they may not apply these skills unless their mindsets agree that they are able to apply such skills (Yeager & Dweck, 2012:303). Furthermore, even though a learner puts in a lot of effort, effort is not the only determinant of achievement, and it does not necessarily indicate a growth mindset (Dweck, 2015:23).

To develop growth mindsets entails that learners have to reflect on and evaluate their learning (Van Deur, 2018:22), focus on the learning process, adjust their learning strategies, seek help from others (Dweck, 2015:20), and develop resilience to challenges (Yeager & Dweck, 2012:303). It is therefore suggested that educators should encourage growth mindsets, by acknowledging their own need for growth mindsets, displaying openness and honesty to learners about poor achievement, assisting learners to reflect on their achievement, discussing ways to improve their performance, and thus guiding learners to learn from feedback (Dweck,

2015:23). Although openness and honesty regarding feedback is advocated, it should be mentioned that research indicates that positive feedback can trigger intrinsic motivation, while negative feedback will have a negative effect on an individual's intrinsic motivation (Deci & Ryan, 2008:15). Feedback should also be informative rather than controlling, as controlling feedback, although positive as well, can have a negative effect on intrinsic motivation (Ryan, 1982:459). Feedback should thus be carefully planned and should be honest, but still positive and not controlling, in order to develop a growth mindset on SDL and to enhance intrinsic motivation.

In view of the above, mindsets can be seen as a driving force for fostering SDL skills (Bellanca & Guglielmino, 2014:1; Van Deur, 2018:4). Bellanca and Guglielmino (2014:1) are further of the opinion that students should be assisted to develop SDL “habits of mind”, so that they can take a permanent and lifelong SDL approach to decision-making and learning.

The above discussion focused on creating a climate for SDL in the classroom. It was indicated that a change from teacher-directed classrooms to SDL classrooms should be made by both teachers and learners. Positive attitudes towards learning, intrinsic motivation, and mindsets were described as important factors determining SDL. It was thus suggested that the focus should be on nurturing intrinsic motivation, rather than on applying extrinsic motivation strategies. It was further suggested that teachers and learners should strive for growth mindsets to view teaching and learning through an SDL perspective, and that learners should be allowed more control of the information they experience, so that they can satisfy their SDL needs.

In the following section, some strategies to plan for and develop SDL by the educator, as the facilitator of SDL, will be discussed.

3.3.1.2 *The educator as the facilitator of SDL*

Research indicates that students initially fear the notion of SDL and prefer formal instruction at first (Williamson, 2007:67). Furthermore, students' individual differences pose a challenge for designing teaching and learning strategies, especially when the aim is to incorporate strategies to foster SDL (Grow, 1991:125; Kell & Van Deursen, 2002:39). Research by Yang *et al.* (2018:50), for example, has indicated that students have different levels of prior knowledge and apply different learning behaviours. Some tension will thus initially occur between the preferences of students and the preference of the educator regarding teaching-learning strategies that aim to foster SDL (Illeris, 2002:83). Candy (1991:39) accordingly suggests that the ideal relationship between teachers and learners should not resemble that of “master and apprentice”, and that the term “facilitator” rather than “teacher” should be used.

As a facilitator of learning, a teacher that plans to develop SDL is described by Knowles (1975:34) as a “procedural guide” that is “actively involved” (Timmins, 2008:303) in developing learners’ SDL. Planning to be a procedural guide in class is very different from the traditional notion of a teacher as someone that has to present content in class (Knowles, 1975:34). The focus should therefore be on how learners should be guided in their journey of pursuing the SDL process in order to acquire knowledge, rather than being concerned with the content that has to be transmitted (Knowles, 1975:38). Care should, however, be taken not to merely reduce the amount of support and guidance to students. Accordingly, Francom (2010:30) suggests that the level of SDL required in learning activities should initially match students’ readiness, and that a progression towards student-directed learning should be made over a period of time. SDL should thus not be regarded as an activity where learners work independently, but throughout the SDL process intensive input is required from the facilitator as the process guide (Timmins, 2008:305). The facilitator provides structure to the process of SDL and focuses on building trust between the facilitator and the learners, so that the learners can accept the “process structure” of learning, rather than the “content structure” that they are used to (Knowles, 1975:37).

Students must be provided with opportunities to practise SDL competencies (Guglielmino, 2013:5-6; Knowles, 1975:39). Although the educator as the facilitator will have suggestions for teaching-learning strategies, these should be presented in such a way that students can provide input, that they will take ownership of such strategies, and that they will increasingly take responsibility for learning, based on the diagnosis of their learning needs (Knowles, 1975:35). Acquisition of SDL skills should thus be incorporated with acquisition of subject matter knowledge, and it should be done within the context of learning tasks (Francom, 2010:33). In the next sections, suggestions for strategies to enhance SDL will be given.

3.3.1.2.1 Learning within a social context

According to Hiemstra (2013:31), teacher-directed approaches are not sufficient to foster SDL. One aspect that cannot be ignored when selecting teaching-learning strategies to foster SDL is learning within a social and a group context. Accordingly, Bolhuis (2003:329) argues that fostering SDL should include learning as a “social phenomenon”. This view of learning is shared by Candy (1991:22), who states that “learning in its fullest sense is a social activity”, and he accordingly challenges educators to assist learners to accomplish their goals and achieve their potential “within a social context”. Although many learners may view themselves as self-directed individuals that can work on their own (Candy, 1991:42), it is argued that “even truly independent and solitary learning activities” often are “the result of the learner’s membership in some group” (Candy, 1991:22).

3.3.1.2.2 Knowledge surveys as a strategy to foster SDL

Knowledge surveys were originally proposed by Nuhfer and Knipp (2003) as a valuable self-assessment tool that can be used by instructors and students to assess gains in teaching and learning (Nuhfer & Knipp, 2003:59). For instructors, knowledge surveys can inform curriculum development and ensure employment of good instructional practices (Nuhfer & Knipp, 2003:59). Knowledge surveys can further be a means to “promote student learning by improving course organisation and planning” (Nuhfer & Knipp, 2003:59). Accordingly, Decker *et al.* (2014:145) confirmed that self-assessment of competencies (as in knowledge surveys) can change attitudes and behaviour towards learning. In this section it will be indicated that knowledge surveys can also possibly be used as a tool to foster SDL.

According to Wirth and Perkins (2005:11), knowledge surveys are an indispensable tool “for enhancing learning”. They describe knowledge surveys as consisting of a large number of questions that cover the full content of the course, addressing different levels of the cognitive domain (Wirth & Perkins, 2005:1-2). When answering knowledge surveys, students do not give answers to questions, but rather they give an indication of their perceived ability to answer certain questions. Students indicate their perceived ability on a three-part scale, with response options ranging from “I do not understand the question” to “I am confident that I can answer the question” (Wirth & Perkins, 2005:2).

Knowledge surveys are not graded, and therefore do not have the purpose of providing students with course marks. According to Wirth and Perkins (2005:3), the knowledge survey rather serves as a learning guide that provides students with statements that focus on course objectives and learning goals. Thus, instead of focusing on course content and facts, knowledge surveys “clarify higher-order learning objectives” (Wirth & Perkins, 2005:3) and assist students to identify “gaps in their understanding” (Wirth & Perkins, 2005:4). Clauss and Geedey (2010:22) accordingly reported that students found knowledge surveys to be a “good reality check”, illuminating areas of the learning material that they had to pay attention to. Clauss and Geedey (2010:22) further found that by asking students to assess their knowledge with knowledge surveys, metacognition is fostered.

Although no literature could be found that explicitly confirms that SDL can be fostered by using knowledge surveys as a self-assessment tool, knowledge surveys have been confirmed to improve aspects related to SDL, such as determining learning needs, metacognition, and attitudes towards learning. Therefore, from an SDL perspective, knowledge surveys can assist students to diagnose their learning needs, by evaluating learning outcomes. Students may thus reflect on their learning and be encouraged to find appropriate resources and implement appropriate learning strategies to satisfy the identified learning needs.

Although SDL is not generally seen as a linear process (see section 3.2.2), the SDL process must be activated, or it must have an origin, namely the individual that identifies their learning needs. From the definition of SDL (Knowles, 1975:20), it can furthermore be assumed that an individual's learning needs will to a great extent determine the rest of the SDL process – what the learning goals will be, which resources will be used, and what learning strategies will be applied. Ultimately, learning outcomes will be evaluated according to the learning needs that were originally identified.

In this section SDL was defined, various views on SDL were discussed, and the value of fostering SDL in education was indicated. The educator's role in fostering SDL as a "procedural guide" (Knowles, 1975:34) was also discussed. Suggestions for fostering SDL in the classroom, such as learning in a social context, were made. Lastly, knowledge surveys were discussed as a possible tool to assist students in identifying their learning needs and developing their metacognition, and thus fostering SDL.

3.4 INTEGRATING DEEPER LEARNING AND SELF-DIRECTED LEARNING

In this section, an attempt will be made to integrate DL and SDL. When viewing SDL through a DL lens, the following question arises: "How do SDL characteristics relate to competencies required for DL, and how does SDL as a process relate to DL as a process?" In this section an attempt will be made to answer this question, moving towards a rationale for DSDL. Characteristics and skills attributed to self-directed learners will be compared with those associated with deeper learners. Thereafter, an attempt will be made to indicate how the processes of DL and SDL are related.

Guglielmino *et al.* (2009:25) state that learning is for far too many students associated with passiveness, boredom, routine, memorisation of facts, and working towards goals set by their educators. As already indicated in the discussion in section 3.2, having good self-directed learning skills is essential for students to develop their full learning potential (Williamson, 2007:66) and be lifelong learners who can fulfil the requirements of a "rapidly changing society" (Guglielmino *et al.*, 2009:25). High SDL is also associated with deep approaches to learning (Candy, 1991:296). Thus, characteristics of self-directed learners will be categorised according to deeper learning competencies, in order to compare characteristics of self-directed learners and deeper learners.

3.4.1 Implications of self-directed learning for 21st-century skills

One of the aims of education is to enhance specific skills (Candy, 1991:317). In chapter 2, 21st-century competencies required for DL were discussed (see section 2.2.2). In this section, characteristics or attributes that are required for SDL will be discussed from the perspective of DL competencies. As SDL contributes to the "whole person" (Candy, 1991:6), SDL

competencies will also be discussed within the cognitive, intrapersonal and interpersonal domains (see section 2.2.2.2), to align SDL and DL competencies.

3.4.1.1 Cognitive competencies

The National Research Council (NRC) (2012:32) describe cognitive competencies as cognitive processes and strategies, for example critical thinking, problem-solving, analysing and reasoning, knowledge (including procedural knowledge), creativity, and innovation. Self-directed learners are required to be consciously aware of cognitive processes when learning (Long, 2000:18). According to Zimmerman (2013:137), activities such as planning and goal setting can also be defined as cognitive competencies. Being goal-oriented is linked to high levels of SDL (Boyer & Usinger, 2015:25; Guglielmino, 1978:73). Self-directed learners are able to apply basic study skills, and they have the ability to plan and pace their studies, and thus to complete tasks within deadlines (Guglielmino, 1978:73). When goal setting is done by teachers, however, Long (2005:2) argues that SDL is inhibited, as learners are not provided with opportunities to identify what is important to learn and to identify problems.

SDL has been found to be significantly and positively related to strategic thinking (Zsiga, 2008:306), creativity, and curiosity (Edmondson *et al.*, 2012:40). Students with higher SDL are described as being more curious, and thus have a higher desire for information and knowledge (Edmondson *et al.*, 2012:42; Guglielmino, 1978:73). Creativity, critical thinking, curiosity, and problem-solving are mentioned as interwoven concepts. Enhancing creativity in the classroom is seen as a means to foster SDL (McDonald & McLaughlin, 2010:66), while creativity is regarded as integral to develop intuition in problem-solving (Edmondson *et al.*, 2012:41; Johnson & Johnson, 2013:299). Furthermore, centring learning on problem-solving opportunities can lead to increased transfer and fostering of SDL (Francom, 2010:37).

Critical thinking is seen as a key factor in student creativity (Jahnke *et al.*, 2017:88). Curiosity, in turn, has been mentioned as “an essential element of critical thinking” (Wagner, 2014:37). When essential questions are included to foster critical thinking (Cypret-Mahach, 2018:161), they should be intellectually engaging, they should require higher-order thinking, and they should stimulate further inquiry (McTighe & Wiggins, 2013:3), and thus stimulate creativity and curiosity, which, in turn, should foster SDL.

Although little research could be found that correlates critical thinking and SDL, research by Bailey and Mentz (2017:102) suggests that incorporating critical thinking in a pair programming environment could develop SDL. Critical thinking is accordingly often mentioned as a competency required by self-directed learners (Bolhuis, 2003:332; Borrás, 2016:9; Boyer & Usinger, 2015:23; De Beer & Gravett, 2017:42; Kell & Van Deursen, 2002:32; Mariano &

Batchelor, 2018:152; Patterson *et al.*, 2002:29). Garrison (1992:147) accordingly states that a core element of critical thinking is to take responsibility for learning.

3.4.1.2 *Intrapersonal competencies*

Intrapersonal competencies required for SDL can be described as having complex attitudes and a desire to learn (Guglielmino, 2014:1). Bolhuis (2003:340-341) states that SDL “requires meta-affective regulation”, perseverance, “rewarding oneself”, and the ability to deal with uncertainty. According to Guglielmino (1978:73), highly self-directed learners enjoy learning, are self-confident, and display initiative and independence.

Research has further indicated that self-directed learners have higher levels of self-efficacy (Cazan & Schiopca, 2014:641), which influences how they “feel, think, motivate themselves, and behave” (Bandura, 1993:118). Learners with strong “perceived self-efficacy” will therefore set higher goals and be committed to them (Bandura, 1993:118). Having high self-efficacy is therefore a key characteristic of self-directed learners.

Self-directed learners will thus have positive attitudes towards learning (Guglielmino, 2014:1). They will be autonomously and intrinsically motivated, will continuously monitor their learning progress, will identify their shortfalls, will make conscious efforts towards self-improvement, and will thus be responsible, self-disciplined individuals (Williamson, 2007:67). Research has found a positive relationship between SDL and life satisfaction, as well as between SDL and future aspirations (Edmondson *et al.*, 2012:40; Guglielmino, 1978:73). SDL intrapersonal characteristics are considered to be a driving force for innovation, and they will thus encourage learners to pursue and persist in finding solutions for challenging problems (Guglielmino *et al.*, 2009:11). SDL has also been found to be significantly related to agreeableness, conscientiousness, emotional stability, and openness (Kirwan *et al.*, 2010:21). According to Gavriel (2015:65), it would be naïve to ignore emotional intelligence and emotional maturity when developing SDL. Self-direction is described by Bolhuis (2003:340) as depending on emotional intelligence. Intrapersonal competencies related to emotional intelligence are self-awareness, self-regulation, and motivation (Goleman, 1998:318), which will be discussed below.

Various models indicating the main intrapersonal competencies that should be developed to improve SDL exist. Simper *et al.* (2016:1159) identified self-efficacy, motivation, and learning belief, among others, as dimensions of lifelong learning. Gavriel (2015:9) suggests a three-pillar model comprising skills, motivation, and self-belief. In the following section the intrapersonal competencies of SDL will be viewed through the lens of a psychological conceptualisation of SDL, as described by Long (2000:16). According to Long (2000:16), SDL is driven by primary and secondary internal processes (see Figure 3.1). Long (2000:16) argues that effective SDL will not be possible without these processes. The primary and secondary dimensions of the

psychological conceptualisation of SDL as described by Long (2000:16) will accordingly be discussed.

3.4.1.2.1 The primary dimensions of SDL as a psychological conceptualisation

Long (2000:16) names motivation, metacognition, and self-regulation as the primary dimensions that drive SDL (Gavriel, 2015:15), as indicated in Figure 3.1. These dimensions will therefore be elaborated on.

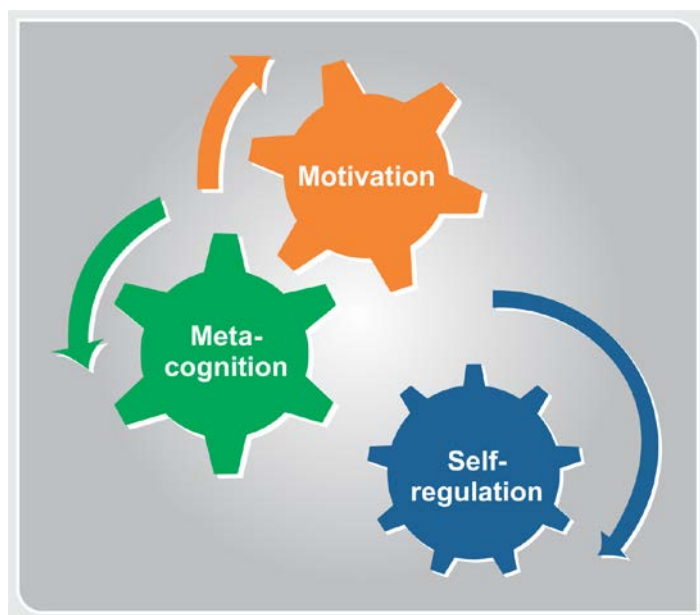


Figure 3.1: SDL as a psychological conceptualisation (Long, 2000)
(Source: own contribution)

Motivation is widely mentioned as an important intrapersonal competency to develop when fostering SDL (Du Toit-Brits & Van Zyl, 2017:50; Gavriel, 2015:15; Payne *et al.*, 2014:44). Motivation is furthermore “highly valued” (Ryan & Deci, 2000b:69) in all aspects of life, and also in education. According to Ryan and Deci (2000b:69), motivation is seen as the internal dimension that “produces”, or that which “moves people to act, think and develop” (Deci & Ryan, 2008:14). Long (2000:16) describes motivation as the “energy, drive, or desire that encourages, impels, or sustains an individual to accomplish a goal or task”. According to Williamson (2015:26), “motivation refers to a learner’s self-efficacy and autonomy”. Motivation is also regarded as being at the core of cognitive and social development and regulation (Ryan & Deci, 2000b:69). According to Deci and Ryan (2008:14), motivation is especially a contributing factor when learning complex tasks, or when something has to be discovered, thus where “deep information processing or creativity” (Deci & Ryan, 2008:14) is involved.

Two categories of motivation are generally described, namely intrinsic motivation and extrinsic motivation (Long, 2000:17; Ryan & Deci, 2000a:55), which are seen as opposing concepts (Deci & Ryan, 2008:15). In terms of an operational definition, intrinsic motivation is described as

“doing something because it is inherently interesting or enjoyable” (Ryan & Deci, 2000a:55). Extrinsic motivation, by contrast, is described as doing something “because it leads to some separate consequence” (Deci & Ryan, 2008:15). An individual can also be described as being amotivated, meaning that they have neither intrinsic nor extrinsic motivation (Deci & Ryan, 2008:15). Maslow (1943:394) proposed that humans are motivated by five basic needs – “physiological needs”, “safety needs”, love or “belongingness needs”, “self-esteem needs”, and the need for self-actualisation. The first four needs that Maslow indicated can be seen as extrinsic motivation needs.

According to Maslow (1943:393), “a satisfied need is not a motivator”. Accordingly, a need for SDL should exist or should be created to motivate students to become more self-directed in their learning. Gavriel (2015:20) proposes that educators need to tap into the human need for self-actualisation to successfully motivate learners to become self-directed. It should, however, be kept in mind that the lowest unmet need will drive individuals (Gavriel, 2015:19; Maslow, 1943:394). As self-actualisation is the highest need in Maslow’s hierarchy, all the other needs first have to be met before learners can truly be encouraged to pursue self-actualisation (Gavriel, 2015:20).

According to Ryan and Deci (2000b:70), intrinsic motivation can be considered the single phenomenon that reflects the “positive potential of human nature”. As individuals further have a natural disposition towards mastery and curiosity, intrinsic motivation will influence learning, exploring, discovering, and seeking new challenges, thereby moving the individual beyond their capacities (Ryan & Deci, 2000b:70).

A question that has frequently been posed by researchers is whether intrinsic motivation can be produced by applying extrinsic motivation strategies (Deci & Ryan, 2008:15). A meta-analysis of this question has mostly confirmed that by using extrinsic motivation strategies, intrinsic motivation will most probably be undermined and learners will lose interest (Deci *et al.*, 1999:627). It is therefore argued by Deci and Ryan (2008:15) that while intrinsic motivation leads to a sense of autonomy, extrinsic motivation, such as rewards, threats, deadlines, and even evaluation, diminishes the feeling of autonomy, because individuals then feel pressurised and that they are being controlled.

According to self-determination theory, two types of motivation that include intrinsic and extrinsic motivation are autonomous motivation and controlled motivation (Deci & Ryan, 2008:14). Autonomous motivation comprises intrinsic motivation and “well-internalized extrinsic motivation”, while controlled motivation comes from external sources (Deci & Ryan, 2008:14). Motivation can be seen as a predictor for some intrapersonal SDL characteristics, which are explained as follows. Autonomous motivation is particularly regarded as a predictor for

persistence and commitment (Deci & Ryan, 2008:14, Guglielmino, 1978:73). Intrinsic motivation is often associated with curiosity and a desire for challenge (Long, 2000:17; Ryan & Deci, 2000b:71), both of which are characteristics of highly self-directed learners (Edmondson *et al.*, 2012:45; Guglielmino, 1978:73).

Metacognition can simply be described as “thinking about thinking”, thus monitoring one’s own thinking and being conscious of what one is thinking (Long, 2000:18). According to Zimmerman (2013:137), the use of strategies to organise or transform information can be described as metacognitive activities. Long (2000:18) defines the term “executive control” as referring to when a learner monitors and is alert to their state of thinking.

Research has indicated a correlation between SDL and metacognition (Long, 2000:18; Mariano & Batchelor, 2018:152; Shannon, 2008:26; Van der Walt, 2014:7). According to Long (2000:18), SDL can be enhanced when a learner engages executive control and metacognitive processes. Metacognition has even been called “the engine that drives self-directed learning” (Shannon, 2008:18). Highly self-directed learners will thus be aware of the cognitive processes they apply in learning and will be able to reflect on personal failures and successes (Long, 2000:19). Therefore, when engaging in problem-solving, metacognition will be displayed by learners who evaluate and adjust strategies during problem-solving (Long, 2000:18). It is, however, proposed that educators should aim to enhance learners’ metacognitive awareness by applying appropriate strategies to explicitly develop learners’ metacognitive skills (Breed, 2013a:14), which will thus enhance their SDL (Shannon, 2008:26).

Long (2000:19) states that *self-regulation* is a critical element of SDL and is a natural outflowing of metacognition, and thus self-regulated learning (SRL) is often mentioned when discussing SDL (Van Deur, 2018:5). Because both the words “self” and “learning” are included in the concepts of SDL and SRL, these two concepts are intertwined and are “often used interchangeably” (Bolhuis, 2003:335; Loyens *et al.*, 2008:417). The word “self-regulation” is often used to define the term “self-direction” (Shi & Witte, 2018:112).

Zimmerman (2013:137) defines SRL as “the degree to which students are metacognitively, motivationally, and behaviorally active participants in their own learning processes”. According to Shi and Witte (2018:113), self-regulating learners take control of personal, behavioural and environmental matters to achieve their academic goals. SRL is often specifically mentioned when an individual aims to master a specific skill (Zimmerman, 2013:137). SRL further has a cyclical nature, and it requires that learners apply proactive strategies to plan, monitor and regulate their learning (Shi & Witte, 2018:113), by identifying shortcomings in their learning approach and finding ways to address these shortcomings in order to succeed (Zimmerman,

2013:137). Thus, when engaging in self-regulation, a learner must be able to display self-control and continuously focus on metacognitive processes (Long, 2000:19).

Thus, when comparing SRL to Knowles' (1975:18) definition of SDL (see section 3.2), overlapping sub-processes are identified, namely goal setting, task analysis, selecting strategies, and self-evaluation (Long, 2000:20; Loyens *et al.*, 2008). Furthermore, both SRL and SDL focus on student control, both activate metacognitive skills, and both view intrinsic motivation as important (Loyens *et al.*, 2008:417-418). According to Loyens *et al.* (2008:418), SDL is a broader concept than SRL, as it also includes the premise of giving students the opportunity to select "what will be learned" (Loyens *et al.*, 2008:418), to define and initiate the learning task, and to evaluate the selected learning materials critically. A lengthy discussion of the similarities and differences between SRL and SDL is, however, not within the scope of this study, and therefore only a brief discussion of SRL will be provided, in order to elaborate on the link between SRL and SDL.

SRL can thus be described as regulating the self during cognition, and it will accordingly have an apparent influence on the quality of a learner's SDL (Long, 2000:20). SRL thus focuses more on the actual activities necessary to move towards learning goals, while SDL focuses on the goals that learners set (Bolhuis, 2003:335). It can therefore be stated that self-regulation must continuously be applied throughout the process of SDL.

In this section, the primary intrapersonal dimensions of SDL, namely motivation, metacognition, and self-regulation, were discussed. In the following section, the secondary intrapersonal dimensions will be discussed.

3.4.1.2.2 The secondary dimensions of SDL as a psychological conceptualisation

Long (2000:20) identified four secondary dimensions of SDL, namely choice, competence, control, and confidence. In the above section, in the discussion of the primary dimensions, the secondary dimensions were mentioned, as they are interwoven with the primary dimensions. It was further mentioned above that intrinsic motivation is undermined when *control* is exerted on an individual by means of extrinsic motivation or controlled feedback. In section 3.3.1.1 it was suggested that learners should have more *control* over the information that they are exposed to. It was also mentioned that autonomous motivation, where individuals experience a sense of *choice* (Deci & Ryan, 2008:14), is a predictor for enhancing SDL characteristics.

Accordingly, Long (2000:21) states that control and choice are closely linked. For instance, when a learner is able to make choices in learning, their awareness of control will be affected (Long, 2000:21). According to Deci and Ryan (2008:14), considerable research indicates that when the basic human need for *competence* is met, autonomous motivation is enhanced (Deci

& Ryan, 2008:14). It is thus unlikely that a learner will be self-directed in an area in which they feel incompetent (Long, 2000:21). Self-directed learners will also thus experience more feelings of competence and confidence (Long, 2000:22), which should lead to more effort (Long, 2000:22). For learners to apply their skills and abilities, they should therefore have confidence, they should believe in their abilities, and they should have growth mindsets (see section 3.3.1.1).

All self-directed learners will inevitably make use of the above-mentioned primary dimensions (motivation, metacognition, and self-regulation) and secondary dimensions (choice, competence, control, and confidence) (Long, 2000:23). These dimensions will “supplement and reinforce each other to contribute to the most positive outcomes” of SDL (Long, 2000:23).

3.4.1.3 *Interpersonal competencies*

Self-directed learners are envisaged as learners willing to collaborate and seek assistance from other people and peers (Knowles, 1975:18). The importance of learning in a social context to foster SDL has already been mentioned in section 3.3.1.2.1 and has also been confirmed in the literature. Guglielmino *et al.* (2009:24) argue that self-directed learners should not be labelled as “non-social” learners who are interested in promoting “individualistic or materialistic” interests, but rather as learners willing to share knowledge with others and who want to apply their knowledge to improve society. In research conducted by Boyer and Kelly (2005:14), they found that the “social element was deemed vitally important to many of the participants”.

Knowles (1975:71-72) indicates several competencies of self-directed learners that emphasise collaboration with others, namely (1) to experience other learners as collaborators rather than as competitors, (2) to identify resources needed from other learners, (3) to identify what resources can be provided to others, (4) to participate in mutual learning, and (5) to participate in group sharing, that is, explaining what and who you are. Self-directed learners should therefore be able to explain to other learners, they should see peers as resources, they should give help to others, and they should be able to receive help from them (Knowles, 1975:61), thus being “mutually helpful human beings” (Knowles, 1975:71).

Emotional intelligence, as discussed in the above section, also requires interpersonal competencies, such as recognising the feelings of others, managing emotions in relationships, and having empathy and social skills (Goleman, 1998:317-318). Empathy is defined as to sense what others feel, the ability to take others’ perspectives, and the ability to cultivate “rapport and attunement with a broad diversity of people” (Goleman, 1998:318). Skills specifically mentioned with regard to social skills are cooperation and teamwork skills to interact with others, negotiate, and settle disputes (Goleman, 1998:318).

In this section interpersonal competencies were indicated as essential for self-directed learners, along with cognitive and intrapersonal characteristics. The characteristics of self-directed learners were categorised within the cognitive, intrapersonal and interpersonal domains and were described accordingly. Although all characteristics and skills, or competencies, can be seen as being within a person, therefore intrapersonal, the above discussion was specifically provided to align SDL competencies with DL competencies (see section 2.2.2.2). Table 3.1 provides a summary of the classification of SDL characteristics within the cognitive, intrapersonal and interpersonal domains.

Table 3.1: SDL competencies in the cognitive, intrapersonal and interpersonal domains

COGNITIVE	INTRAPERSONAL	INTERPERSONAL
• Comfortable with uncertainty and change (Kell & Van Deursen, 2002:32). • Creativity (Edmondson <i>et al.</i>, 2012:45; Guglielmino, 2013:9). • Critical thinking (Bailey & Mentz, 2017:102; Bolhuis, 2003:332; Borrás, 2016:9; Boyer & Usinger, 2015:23; De Beer & Gravett, 2017:42; Garrison (1992:147; Kell & Van Deursen, 2002:32; Mariano & Batchelor, 2018:152; Patterson <i>et al.</i>, 2002:29). • Curiosity for learning (Edmondson <i>et al.</i>, 2012:45; Guglielmino, 1978:73; Knowles, 1975:21). • Goal-oriented (Guglielmino, 1978:73). • Initiative (Guglielmino, 1978:73; Kell & Van Deursen, 2002:32). • Innovation (Guglielmino <i>et al.</i>, 2009:10). • Manages own learning (Dehnad <i>et al.</i>, 2014:5186; Guglielmino, 1978:73). • Manages time (Guglielmino, 1978:73; Kell & Van Deursen, 2002:32). • Needs to know (Knowles, 1975:21). • Needs to analyse (Guglielmino <i>et al.</i>, 2009:19).	• A desire to change (Guglielmino, 1978:73). • A desire to learn (Guglielmino, 1978:73). • A growth mindset (Dweck, 2015:10; Van Deur, 2018:4; Yeager & Dweck, 2012:303). • Ambition (Guglielmino <i>et al.</i>, 2009:19). • Attitudes towards learning (Guglielmino, 2013:8). • Completes work (Guglielmino, 1978:73). • Conscientiousness, agreeableness, emotional stability and openness (Kirwan <i>et al.</i>, 2010:21). • Emotional intelligence (Gavriel, 2015:65). • Enjoys learning (Guglielmino, 1978:73). • Evaluates own learning (Merriam <i>et al.</i>, 2007:107). • Independence (Guglielmino, 1978:73). • Life satisfaction (Edmondson <i>et al.</i>, 2012:45). • Metacognition (Breed, 2013a:14; Loyens <i>et al.</i>, 2008:417; Van der Walt, 2014:7). • Motivation (Guglielmino <i>et al.</i>, 2009:19; Knowles, 1975:21; Long, 2000:17; Loyens <i>et al.</i>, 2008:417; Van Deur, 2018:4). • Overcomes obstacles or hardships (Guglielmino <i>et al.</i>, 2009:19). • Passion (Guglielmino <i>et al.</i>, 2009:19). • Perseverance (Bolhuis, 2003:341; Kell & Van Deursen, 2002:32). • Persistence (Guglielmino, 1978:73). • Proactive in learning (Merriam <i>et al.</i>, 2007:107; Williamson, 2007:66).	• Altruistic (Guglielmino <i>et al.</i>, 2009:23). • Collaborative (Knowles, 1975:61). • Empathy towards others (Gavriel, 2015:65; Goleman, 1998:317). • Explains to others (Knowles, 1975:61). • Helps others (Knowles, 1975:61). • Receives help from others (Knowles, 1975:61). • Shares knowledge (Guglielmino <i>et al.</i>, 2009:24). • Social responsibility (Guglielmino <i>et al.</i>, 2009:19). • Views peers as resources (Knowles, 1975:61). • Views others as mutually helpful (Knowles, 1975:61).

Table 3.1: SDL competencies in the cognitive, intrapersonal and interpersonal domains (cont.)

COGNITIVE	INTRAPERSONAL	INTERPERSONAL
• Seeks knowledge (Guglielmino <i>et al.</i>, 2009:19). • Paces learning (Guglielmino, 1978:73). • Problem-solving (Guglielmino, 2013:9). • Strategic thinking ability (Zsiga, 2008:306). • Vision (Guglielmino <i>et al.</i>, 2009:19).	• Problems are seen as challenges (Kell & Van Deursen, 2002:32). • Reflection (Patterson <i>et al.</i>, 2002:28; Van Deur, 2018:3). • Resilience (Guglielmino, 2013:6; Yeager & Dweck, 2012:303). • Responsibility for own learning (Dehnad <i>et al.</i>, 2014:5186; Guglielmino, 1978:73; Merriam <i>et al.</i>, 2007:107). • Risk taking (Guglielmino <i>et al.</i>, 2009:19). • Self-confidence (Guglielmino, 1978:73; Kell & Van Deursen, 2002:32). • Self-discipline (Guglielmino, 1978:73). • Self-efficacy (Bandura, 1993:118; Cazan & Schiopca, 2014:641; Zimmerman, 2013:137). • Self-reliance (Guglielmino <i>et al.</i>, 2009:19).	

It is debatable whether transfer should be categorised as a cognitive competency, but in view of transfer as an outcome of DL, and not specifically as a 21st-century competency, the implications of SDL on transfer will be discussed separately.

3.4.2 The implications of self-directed learning on transfer

Not much research could be found that specifically relates SDL and transfer. However, as Bolhuis (2003:339) indicates, teaching should always aim for transferable knowledge and skills. Whether high levels of SDL will be conducive to transfer, and whether improving students' SDL will improve their transfer, is debatable. Ayyildiz and Tarhan (2015:664) state that students that control their learning experiences "can easily transfer what they have learnt". Their statement should, however, not be believed unquestioningly, as will be indicated in the following discussion.

The statement made by Ayyildiz and Tarhan (2015:664) above is based on research conducted by Boyer and Kelly (2005). Boyer and Kelly's intervention, however, incorporated many strategies to improve students' SDL, for example an online component, social learning, and authentic environments (Boyer & Kelly, 2005:15-16). They concluded that the learning of the participants was transformed as a result of their interventions (Boyer & Kelly, 2005:15), which does not specifically refer to learning transfer. Ayyildiz and Tarhan's (2015:664) statement on transfer in SDL can therefore not be regarded as supported by research.

Research has indicated that transfer can vary meaningfully among participants, even though participants may have the same overall levels of certain characteristics that have been shown to predict transfer (Huang *et al.*, 2017:558). Characteristics required for transfer are therefore considered to be context-dependent, and they will vary among individuals (Huang *et al.*, 2017:559). As indicated in section 2.2.3, transfer is a complex issue and is also determined and affected by many variables (see section 2.2.3.2). It can therefore be assumed that having a high level of SDL readiness will probably not be sufficient to implicate transfer. Whether a student's level of SDL will affect transfer of knowledge can therefore only be speculated on.

It is often assumed that students' SDL skills will transfer to new learning situations (Kell & Van Deursen, 2002:32). Research, however, has indicated that SDL is context-specific (Cazan & Schiopca, 2014:643; Van der Walt, 2014:7). Therefore, students' SDL may differ from context to context, and it can be influenced by different factors in different contexts, such as the student's level of intrinsic motivation and the difficulty of the content (see section 3.4.1.2.2).

In view of the above, it can thus be said that the influence of SDL on transfer is still a debatable issue. Research has not sufficiently indicated that students' inclination to being self-directed learners will determine their transfer of knowledge and skills. Being self-directed and being able

to transfer knowledge are, however, both crucial to learning, as indicated in this thesis. It is therefore proposed that the focus should not be on how the one implicates the other, but on how the processes of DL and SDL can be integrated to incorporate both self-direction in learning and transfer of knowledge and competencies.

3.4.3 Providing a rationale for deeper self-directed learning

When trying to distinguish between or trying to determine the relationship between SDL and DL, these two concepts should be viewed from different perspectives. Firstly, they can be viewed from the perspective of competencies required for the processes of DL and SDL. It has already been indicated that both processes require competencies in the cognitive, intrapersonal and interpersonal domains. Aligning and mapping these competencies becomes an onerous task, however, due to the number of competencies implicated and the overlapping of competencies in both SDL and DL. The National Research Council (NRC) (2012:89) furthermore includes being self-directed as an intrapersonal competency for DL. Thus, as indicated by Bellanca and Guglielmino (2014:2), the processes of DL and SDL become recursively intertwined, with the one mutually driving the other. The processes of DL and SDL can therefore not be clearly distinguished by taking a perspective of required competencies.

Secondly, the processes of SDL and DL can be viewed according to the outcomes or aims envisaged by each process. As indicated in section 3.2.2, the aim or outcome of SDL is to enhance learners' SDL to an optimal level, to instil independent and lifelong learning and to make learners take full responsibility for their learning. The outcome of the process of DL, by contrast, is transferable knowledge and competencies (see section 2.2.3). It should also be mentioned that the two processes of DL and SDL each have no final outcome – optimal levels of SDL and DL cannot be reached. SDL and DL can thus be described as infinite processes, aiming for more and more DL and SDL. When viewing the processes from the perspective of their outcomes or aims, the two processes can clearly be distinguished.

Thus, when distinguishing between SDL and DL, the focus should not be on required competencies, but rather on the outcomes of each process. DL focuses on transfer of knowledge, and SDL focuses on taking ownership of learning and evaluating learning outcomes. Another common thread woven into both processes is that neither of these processes can be ignored or excluded when preparing learners for the 21st century (Bellanca & Guglielmino, 2014:2). The outcomes of these processes will not happen by chance, and teachers have to intentionally foster DL and SDL in the classroom and beyond (Bellanca & Guglielmino, 2014:2; Martinez *et al.*, 2016:7).

It is therefore posited that the individual processes of DL and SDL, on their own, are not sufficient for 21st-century learning and acquisition of 21st-century competencies. To effectively

prepare learners for the 21st century, the focus of teaching must be on deeper self-directed learning (DSDL), where learners take ownership of and responsibility for their learning, where the aim is for them to transfer knowledge to new contexts.

In Figure 3.2, the DSDL process is graphically represented by means of a Fibonacci spiral, which spirals inwards infinitely (Reich, 2018). On the outer boundaries lie the cognitive, intrapersonal and interpersonal domains of DL and SDL. As the forces driving DL and SDL (a learning need to take ownership of learning, develop 21st-century competencies and transfer knowledge) are combined, these competencies become more and more intertwined, spiralling inwards towards DSDL, without reaching a saturation point on DSDL.

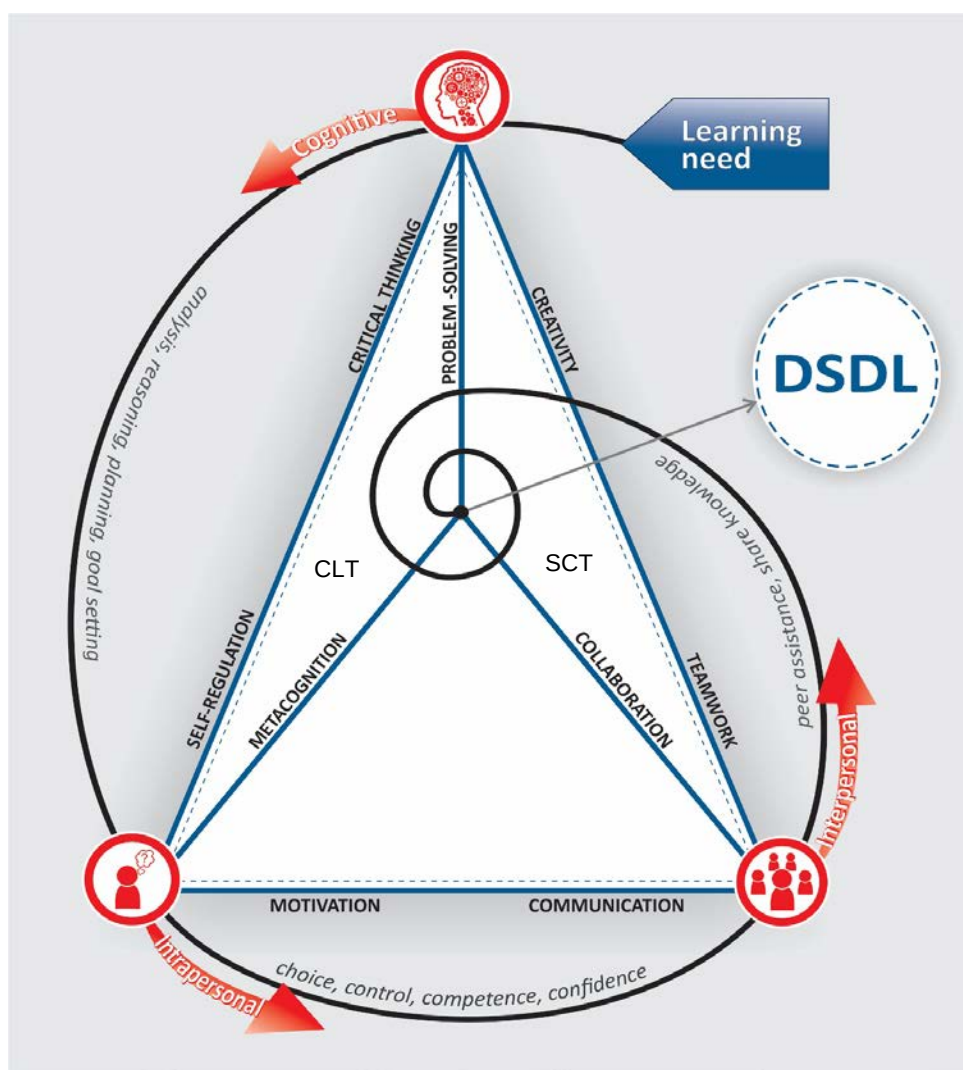


Figure 3.2: Deeper self-directed learning
(Source: own contribution)

Figure 3.2 depicts DSDL as a process initiated by a learning need to transfer knowledge and to acquire 21st-century competencies. As indicated by Hattie and Donoghue (2016:4), when there

is no learning need created for transferring knowledge and acquiring 21st-century competencies but only for acquiring surface knowledge, there will also be no argument for DSDL.

The spiral in Figure 3.2 as proposed by the researcher and based on literature discussed in the preceding sections, indicates that the DSDL process revolves around cognitive, intrapersonal and interpersonal competencies, driven by the primary processes of self-regulation, metacognition, and motivation and the secondary processes of choice, control, competence, and confidence. The ultimate aim of DSDL is far transfer – the transfer of knowledge to new contexts – and for learners to take charge and ownership of the learning process, by formulating learning goals, selecting resources, applying appropriate learning strategies, and evaluating whether learning outcomes have been achieved.

Although it may seem that the inward spiral is collecting competencies linearly, starting with cognitive competencies, it should be noted that learning is not viewed as a linear process. Application of these competencies can occur concurrently and in any order as required by the learning need. Further learning needs will thus be identified when evaluating learning outcomes. Learning needs will be deeper in the DSDL process, and they will not merely entail that learners need to successfully complete an assignment or pass an exam. Learning needs should have a lifelong learning focus – to prepare for success in the 21st century.

In the cognitive domain, a deep approach to learning is required in order to make connections between concepts in the working memory (WM) and the long-term memory (LTM) and to transfer knowledge. Learners will solve problems creatively using their critical thinking skills, while analysing and reasoning. They will continuously set goals, do planning, and monitor their goals. Formulation of learning goals, according to the view of DSDL, should include the essence of transfer. Learning should aim to transfer the competencies gained to areas in the current context, to other contexts, and to real-life situations.

Moving to the intrapersonal domain, learners need to be intrinsically motivated and metacognitively involved in the learning process. They need to evaluate their learning and to determine whether learning goals have been met, while continuously regulating their learning. While monitoring their goals, learners should identify their learning needs, to determine what knowledge they are lacking to reach their goals, and they should accordingly apply SDL abilities to reach their goals. Appropriate learning strategies should be selected and applied, and appropriate resources should be located, in order to meet the identified learning needs and goals.

When regulating their own learning, learners will focus on the activities required to move towards their learning goals. Learners should be allowed to have choices in their learning and

control over information that they are exposed to. The experience of a sense of choice and control should enhance learners' intrinsic motivation, building their confidence. As learners acquire more confidence in their learning and work towards their learning goals, their feeling of competence and their belief in their ability will improve, encouraging them to initiate more effort and increasing their self-direction.

Competencies in the interpersonal domain will provide support to the cognitive and intrapersonal domains and will enhance competencies in these domains. While collaborating and communicating, learners' perspectives on complex tasks, content, and solutions to problems will broaden, which will foster transfer. Their critical thinking will improve as they share knowledge and discuss and debate issues with their peers. Consequently, learners will be able to present more creative solutions to problems, and they will develop transferable knowledge. Teamwork, support from peers, and encouraging each other will build confidence and will foster intrinsic motivation, thereby enhancing SDL.

DSDL will therefore have the aim of instilling lifelong learning mindsets in self-directed learners (Bellanca & Guglielmino, 2014), who apply appropriate strategies, develop 21st-century competencies, and continuously transfer competencies inside and outside the classroom, to successfully face the challenges of the 21st century.

The DSDL process is further seen as being developed and fostered by appropriate teaching-learning strategies that incorporate cognitive load theory (CLT) and social constructivist theory (SCT). The instructional environment should accordingly be designed to reduce cognitive loads on the WM and to encourage connections with knowledge in the LTM. Learning should occur within a social environment, where learners work in supportive groups to construct knowledge, execute complex tasks and solve problems.

With DSDL having been described, cooperative learning (CL) will in the following section now be suggested as a suitable teaching-learning strategy to foster DSDL. Thereafter guidelines will be given for developing DSDL.

3.5 COOPERATIVE LEARNING AS A PROPOSED TEACHING-LEARNING STRATEGY TO FOSTER DEEPER SELF-DIRECTED LEARNING

In view of all the requirements to foster DSDL, CL will in the following section be posited as a suitable teaching-learning strategy to foster DSDL. During the first part of the discussion the focus will be on CL as a teaching-learning strategy to foster SDL. Thereafter CL will be further discussed as a teaching-learning strategy that can also foster DL, and thus DSDL.

3.5.1 Cooperative learning as a teaching-learning strategy to foster self-directed learning

In the early days of SDL research, Tough suggested that SDL competencies can be developed by working with others as resources, including peer groups (Tough, 1978). However, according to Long (2000:14), the interpersonal relationships as described by Tough were limited to selecting and collaborating with individuals who were competent to assist others in learning. Knowles, by contrast, focused on group discussion to foster learning in small groups (Long, 2000:15), and he suggested that groups should be organised in a manner that will be conducive to SDL (Long, 2000:15). Knowles (1975:71) accordingly proposed that peers should not be viewed as competitors and facilitators not as authority figures (Knowles, 1975:71).

In section 3.4.1.2.1 it was indicated that autonomous motivation is a determining factor for SDL. A further argument to support group learning is provided by Deci and Ryan (2008:14). They state that intrinsic motivation can best be fostered in social learning environments, because such environments influence not only what learners do, but also how they feel during and after learning. More specifically, according to Deci and Ryan (2008:15), several studies have indicated that intrinsic motivation can be enhanced by social learning environments that are “supportive and informational” and that support the basic human need of feeling “competent, autonomous and related to others”.

As indicated in section 2.4.1, CL is based on the principle of social interdependence, where individuals do not work competitively, but as a supporting team, where members are mutually dependent on each other. This principle is reminiscent of Knowles’ (1975:71) statement mentioned in section 3.4.1.3, namely that learners and educators should see each other as “mutually helpful human beings” in order for SDL to flourish. CL therefore has the potential to provide a transformative platform for students to become self-directed learners, by incorporating mutual assistance (Knowles, 1975:71), learning in a social context (Bolhuis, 2003:329; Candy, 1991:22), and fostering intrinsic motivation (Deci & Ryan, 2008:15) (see section 3.4.1.2.1).

Research has frequently indicated CL as an effective strategy to foster SDL. Bailey and Mentz (2017:102) suggest cooperative pair programming as a valuable strategy to foster SDL. Breed and Bailey (2018:1) found that SDL can be improved when metacognitive self-questions are incorporated during cooperative pair programming. It was also indicated that students with low levels of SDL readiness skills improved their SDL after implementing CL as a teaching-learning strategy (Mentz & Van Zyl, 2018:482).

According to the above, CL is proposed as a suitable teaching-learning strategy to enhance SDL. In the following section, it will be indicated why CL is also seen as a suitable strategy to foster DSDL.

3.5.2 Cooperative learning and cooperative pair programming as teaching-learning strategies to foster deeper self-directed learning

In chapter 2 (see section 2.4.2), it was indicated that CL, and thus also cooperative pair programming, can positively impact competencies in the cognitive, intrapersonal and interpersonal domains. The benefits of CL and cooperative pair programming on fostering transfer were also discussed in section 2.4.3. CL and cooperative pair programming can therefore be regarded as suitable strategies to foster DL (see section 2.5). Thus, because CL has been indicated as a suitable teaching-learning strategy to foster both SDL and DL, it is hypothesised that CL and cooperative pair programming can be proposed as suitable teaching-learning strategies to foster and develop DSDL.

In the following section guidelines to develop DSDL will be given, as obtained through the literature review and subsequent discussions in chapter 2 and chapter 3.

3.6 GUIDELINES TO DEVELOP DEEPER SELF-DIRECTED LEARNING

In this section, guidelines to develop DSDL are summarised in Table 3.2 to Table 3.9. These guidelines aim to answer research question 2 (to establish guidelines to develop DSDL) and research question 3 (to establish guidelines for practical application in the Computer Applications Technology (CAT) education class at university) (see section 1.3). The guidelines in the first column of each table, numbered in lower-case letters (“a”, “b”, etc.), address research question 2. In the last column of the tables, the practical guidelines for a teaching strategy within a cooperative learning environment are given. These guidelines, in the last column, aim to answer research question 3, and they are numbered in capital letters (“A”, “B”, etc.).

The guidelines to develop DSDL are grouped per table according to the following themes: general guidelines for teaching strategies to develop DSDL (see Table 3.2); guidelines to develop cognitive competencies (see Table 3.3); guidelines to develop intrapersonal competencies (see Table 3.4); guidelines to develop interpersonal competencies (see Table 3.5); guidelines to promote transfer (see Table 3.6); guidelines that support CLT (see Table 3.7); and guidelines that support SCT (see Table 3.8). An additional table, Table 3.9, provides guidelines specifically for implementing CL and cooperative pair programming as teaching-learning strategies to develop DSDL.

The sources where the guidelines were obtained from in the literature review are also listed in the tables, as well as the numbers of the sections where the guidelines are discussed in this thesis. In the third column of each table, the specific concept or theory that the guideline applies to is given. For example, in Table 3.2 the general guidelines “c” to “f” for teaching strategies to develop DSDL specifically apply to and should thus also develop DL, CL, and SDL.

Some tables are split over more than one page. The practical guidelines within a cooperative learning environment are indicated for the sections of a table on a specific page, and a guideline can therefore be suggested more than once in a table.

Table 3.2: General guidelines for teaching strategies to develop DSDL

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Adopt deep approaches to learning. b. Encourage students to direct their own learning.	Biggs & Tang (2011:21); Hewlett Foundation (2017); Nelson Laird <i>et al.</i> (2014:425); Parpala <i>et al.</i> (2010:270); Wilmot and Merino (2015:269)	DL	2.2.1 2.2.2.2	A. Apply CL as a teaching strategy, and incorporate the five essential elements. B. The level of SDL required should match the students' level of readiness, and progression towards self-directed learning should be made over a period of time. C. Incorporate complex tasks.
	Candy (1991:296)	SDL	3.4	
c. Apply active teaching strategies, requiring high levels of student engagement.	Biggs and Tang (2011:22); Grocchia (2018:16); Shulman (2002:38)	DL	2.2.1	
d. Teachers should be viewed as facilitators and procedural guides, rather than as transmitters of knowledge. Facilitators need to provide structure to the process of SDL, inform learners about the purpose of SDL and what is expected of them, and build trust between the facilitator and the learners to accept the process.	Felder and Brent (2007:39); Yamarik (2007:275); Johnson and Johnson (2017:287); Tadesse and Gillies (2015:12)	CL	2.4 2.4.1.1 2.4.2.1	
e. The level of SDL required in learning activities should match the students' level of readiness.	Francom (2010:30); Guglielmino (2013:6); Hiemstra (2013:31); Knowles (1975:32); Timmins (2008:305)	SDL	3.3.1.1 3.3.1.2	
f. Provide opportunities to practise SDL competencies. Integrate acquisition of SDL skills with the acquisition of subject matter knowledge and within the context of learning tasks.				
g. Develop lifelong learning.	Kirby <i>et al.</i> (2010:300); Bellanca and Guglielmino (2014:1); Guglielmino <i>et al.</i> (2009:25); Candy (1991:424); Simper <i>et al.</i> (2016:1159); Smith <i>et al.</i> (2009:19).	DL SDL	2.2.2.2.1 3.2.2 3.3.1.1 3.4.3	

Table 3.3: Guidelines for DSDL to develop cognitive competencies

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Master rigorous academic content.	Nelson Laird <i>et al.</i> (2014:407); Hewlett Foundation (2017)	DL	2.2.2.2	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. B. The level of SDL required should match the students' level of readiness, and progression towards self-directed learning should be made over a period of time. C. Incorporate complex tasks. D. Focus on the element of positive interdependence. E. Focus on the element of individual accountability. F. Integrate essential questions. G. Cultivate the habit of asking good questions. H. Apply constructive controversy in CL. I. Administer knowledge surveys to learners.
	Könings <i>et al.</i> (2019:87); Paas <i>et al.</i> (2010:116)	CLT	2.3.1	
	Felder and Brent (2007:36); Garcha and Kumar (2015:61); Johnson <i>et al.</i> (2008:1:14); Johnson and Johnson (2017:287); Kirschner <i>et al.</i> (2011:622); Malatji (2016:34); Slavin (2013:190); Tadesse and Gillies (2015:12); Yamarik (2007:275)	CL	2.4.2.1 2.4.1.1.1 2.4.1.1.2	
b. Develop critical thinking.	Bellanca (2015:3); Cypret-Mahach (2018:161); Facione (1990:3); Hewlett Foundation (2017); NRC (2012:31-35); Nelson Laird <i>et al.</i> (2014:407); Taylor (2016:13); Viviers (2016:255); Voogt <i>et al.</i> (2013:404); Wagner (2014:26);	DL	2.1.2.2.1 2.2.2.2.1	C. Incorporate complex tasks. D. Focus on the element of positive interdependence. E. Focus on the element of individual accountability. F. Integrate essential questions. G. Cultivate the habit of asking good questions. H. Apply constructive controversy in CL. I. Administer knowledge surveys to learners.
	Bailey and Mentz (2015:142); Bailey and Mentz (2017:102); Johnson and Johnson (2013:320); Smith <i>et al.</i> (2009:19);	CL	2.2.2.2.1 2.4.1.2 2.4.1.3 2.4.2.1	
	Bailey and Mentz (2017:102); Bolhuis (2003:332); Borrás (2016:9); Boyer and Usinger (2015:23); De Beer and Gravett (2017:42); Garrison (1992:147); Kell and Van Deursen (2002:32); Mariano and Batchelor (2018:152); Patterson <i>et al.</i> (2002:29)	SDL	3.2.1 3.4.1.1	

Table 3.3: Guidelines for DSDL to develop cognitive competencies (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
c. Develop problem-solving.	NRC (2012:32); Voogt <i>et al.</i> (2013:404)	DL	2.2.2.2.1	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. C. Incorporate complex tasks. D. Focus on the element of positive interdependence. E. Focus on the element of individual accountability. F. Integrate essential questions. G. Cultivate the habit of asking good questions. H. Apply constructive controversy in CL. I. Administer knowledge surveys to learners. J. Assign complementary roles to group members, or the roles of driver and navigator in cooperative pair programming.
	Chi and VanLehn (2012:178, 181); Francom (2010:37); Lobato (2012:234); Merriam and Leahy (2005:3); Nokes-Malach and Mestre (2013:188)	Transfer	2.2.3.1.1 2.2.3.1.3 3.4.1.1	
	Gillies (2014:131); Sturdy (2005:223); Wray (2010:51)	CL	2.4.1.1.4 2.4.1.3 2.4.2.1	
	Francom (2010:37); Guglielmino (2013:9)	SDL	3.4.1.1	
d. Develop creativity.	Jahnke <i>et al.</i> (2017:87, 88); NRC (2012:32); Voogt <i>et al.</i> (2013:404)	DL	2.2.2.2	
	Johnson and Johnson (2013:320); Johnson and Johnson (2013:450-451)	CL	2.4.1.2	
	Edmondson <i>et al.</i> (2012:40); Guglielmino (2013:9); McDonald and McLaughlin (2010:66); Wagner (2014:37)	SDL	3.2.1 3.4.1.1	
e. Encourage curiosity, strategic thinking, and innovation.	Edmondson <i>et al.</i> (2012:40); Guglielmino (1978:73); Zsiga (2008:306)	SDL	3.4.1.1	
f. Encourage goal setting and time management.	Boyer and Usinger (2015:25); Guglielmino (1978:73); Long (2005:2); Knowles (1975:18); Wirth and Perkins (2005:3); Zimmerman (2013:137)	SDL	3.2 3.4.1.1 3.4.1.2 3.3.1.2.2	

Table 3.4: Guidelines for DSDL to develop intrapersonal competencies

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Develop an academic mindset – a belief in your ability to grow. b. Develop positive attitudes towards learning and literacy, and develop enjoyment of learning and a desire to learn.	Dweck (2015:20); Hewlett Foundation (2017); Nelson Laird <i>et al.</i> (2014:407); Yeager and Dweck (2012:303)	DL	2.2.2.2.1	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. I. Administer knowledge surveys to learners. K. Focus on the element of group processing. L. Include metacognitive questioning.
	Felder and Brent (2007:39); Johnson and Johnson (2015:27); Kirschner <i>et al.</i> (2011:623); Slavin (2011:385); Yamarik (2007:275)	CL	2.4.2.2	
	Cazan and Schiopca (2014:641); Edmondson <i>et al.</i> (2012:40); Guglielmino (2013:8); Guglielmino (2014:1); Van Deur (2018:4)	SDL	3.2.2 3.4.1.2	
c. Develop flexibility, adaptability, responsibility, integrity, self-monitoring, self-reflection, self-efficacy, self-regulation, self-confidence, persistence, self-discipline, resilience, self-evaluation, and the ability to deal with uncertainty. d. Guide learners to learn from feedback. e. Develop metacognition.	Bandura (1977:193, 194); Bolhuis (2003:331); Denhardt (2001:530); McCormick <i>et al.</i> (2013:69); NRC (2012:33, 139); Zimmerman (2000:82); Zimmerman (2002:65)	DL	2.2.2.2.2	
	Breed <i>et al.</i> (2013:52); Felder and Brent (2007:39); Johnson and Johnson (2014:842); Plonka <i>et al.</i> (2015:77); Sharan (2010:303); Veenman <i>et al.</i> (2006:9); Yamarik (2007:275)	CL	2.4.1.1 2.4.2.2	
	Georghiades (2004:379); Papaleontiou-Louca (2003:20)	Transfer	2.2.3.1	
	Bandura (1993:118); Breed (2013a:14); Cazan and Schiopca (2014:641); Dehnad <i>et al.</i> (2014:5186); Dweck (2015:23); Gavriel (2015:9); Gulgielmino (2013:4, 9); Kell and Van Deursen (2002:32); Knowles (1975:21); Long (2000:16, 18, 20); Loyens <i>et al.</i> (2008:418); Mariano and Batchelor (2018:152); Merriam <i>et al.</i> (2007:107); Shannon (2008:26); Shi and Witte (2018:113);	SDL	3.2.1 3.3.1 3.3.1.1 3.4.1.2.1	

Table 3.4: Guidelines for DSDL to develop intrapersonal competencies (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
(cont.)	Van der Walt (2014:7); Van Deur (2018:5); Yeager and Dweck (2012:303); Wirth (2007:110); Zimmerman (2013:137).			A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. I. administer knowledge surveys to learners. K. Focus on the element of group reflection. L. Include metacognitive questioning.
f. Foster intrinsic motivation.	Grossman and Salas (2011:103)	Transfer	2.2.3.2	
g. Enhance intrinsic motivation by social learning environments that are “supportive and informational” and that support the basic human need of feeling “competent, autonomous and related to others”.	Zimmerman (2002:64-65)	DL	2.2.2.2.2	
	Deci and Ryan (2008:14); Du Toit-Brits and Van Zyl (2017:50); Guglielmino (2013:6); Gavriel (2015:15); Knowles (1975:21); Long (2000:16-17); Payne <i>et al.</i> (2014:44); Ryan and Deci (2000b:70-71);	SDL	3.2.1 3.3.1.1	
	Deci and Ryan (2008:15); Johnson and Johnson (2013:320-323); Sharan (2010:303); Slavin (2013:181)	CL	2.4.1.2 2.4.2.2 3.5.1	
h. Improve self-efficacy.	Bandura (1977:194); NRC (2012:33, 139); Zimmerman (2000:82)	DL	2.2.2.2.2	
	Grossman and Salas (2011:103); Merriam and Leahy (2005:6); Blume <i>et al.</i> (2010:1090)	Transfer	2.2.3.2 2.2.3.1.3	
	Felder and Brent (2007:39); Johnson and Johnson (2015:27); Kirschner <i>et al.</i> (2011:623)	CL	2.4.1.1.5 2.4.2.2	
i. Include knowledge surveys as a tool to promote course organisation and planning, enhance learning, change attitudes and behaviour towards learning, foster metacognition, diagnose learning needs, and reflect on learning.	Clauss and Geedey (2010:22); Decker <i>et al.</i> (2014:145); Nuhfer and Knipp (2003:59); Wirth and Perkins (2005:11)	SDL	3.1.3.2.2	

Table 3.5: Guidelines for DSDL to develop interpersonal competencies

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Develop interpersonal skills, such as communication, collaboration, responsible behaviour, teamwork, leadership, decision-making, trust-building and conflict-management skills, appreciation for diversity, and social responsibility. b. Individuals should have the view that the work they are doing mutually benefits each other. c. Assign complementary roles to group members, meaning that one role cannot be performed without the other. d. Self-directed learners should experience other learners as collaborators rather than as competitors; identify resources needed from other learners; identify what resources can be provided to others; participate in mutual learning and group sharing, that is, explaining what and who you are; be able to explain to other learners, see peers as resources, give help to others and be able to receive help from them; and recognise the feelings of others, manage emotions in relationships, and have empathy and social skills.	Hewlett Foundation (2017); NRC (2012:34); Smith <i>et al.</i> (2009:20); Taylor (2016:11); Viviers (2016:254-255); Voogt <i>et al.</i> (2013:405)	DL	2.2.2.2.3 2.2.2.2.4	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. D. Focus on the element of positive interdependence. K. Focus on the element of group reflection. M. Focus on the element of face-to-face promotive interaction. J. Assign complementary roles to group members, or the roles of driver and navigator in cooperative pair programming.
	Gillies (2014:129-130); Johnson <i>et al.</i> (2008:1:14); Johnson and Johnson (2014:850, 854); Johnson and Johnson (2017:286)	CL	2.4.1.1.1 2.4.1.1.3 2.4.1.1.4	
	Thomas <i>et al.</i> (2014:2); Murphy <i>et al.</i> (2005:342); John-Steiner and Souberman (1978:126)	SCT	2.3.2	
	Bailey and Mentz (2017:102); Bolhuis (2003:343); Boyer and Kelly (2005:14); Breed and Bailey (2018:1); Candy (1991:22); Goleman (1998:317-318); Deci and Ryan (2008:14-15); Guglielmino <i>et al.</i> (2009:24); Knowles (1975:18, 61, 71-72); Long (2000:15); Tough (1978); Mentz and Van Zyl (2018:482)	SDL	3.2.2 3.4.1.3 3.4.2 3.5.1	

Table 3.6: Guidelines for DSDL to promote transfer

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Guide novices to recognise similarities and possible transfer situations, and to make abstract representations in order to recognise deep-structure similarities in far-transfer situations. b. Provide repeated experience with the same information but in different contexts, to assist in identifying the similarities between problems. c. Encourage learners to make connections, and foster their inclination towards transfer. d. Transfer is a process. Students do not need to learn everything correctly the first time in order to ultimately achieve successful transfer. e. Combine strategies to foster transfer, and increase the time spent on transfer interventions.	Blume <i>et al.</i> (2010:1096); Chi and VanLehn (2012:181); Collard <i>et al.</i> (2016:249); Goldstone and Day (2012:150); Kurtz and Loewenstein (2007:338); Lobato (2012:233); Nokes-Malach and Mestre (2013:187)	Transfer	2.2.3.1.1 2.2.3.2	N. Assist learners in recognising deep similarities in problem scenarios, to develop far transfer. O. Provide repeated experience with the same information but in different contexts, to assist in identifying the similarities between problems. P. Compare and contrast examples to identify deep-structure similarities. Q. Provide unsolved problems that can be compared to facilitate analogical retrieval.
f. Reduce the intrinsic cognitive load and the extraneous cognitive load in the early phases of learning complex tasks. g. Compare and contrast examples to identify deep-structure similarities. h. Expose learners to a variety of learning conditions that include a variety of problems and solutions, to be practised in random order. i. Learning tasks should right from the outset provide limited feedback and guidance and be structured in task classes, to provide a holistic view.	Hatala <i>et al.</i> (2003:25); Kurtz and Loewenstein (2007:334); Norman (2009:809); Schwartz <i>et al.</i> (2012:208); Van Merriënboer <i>et al.</i> (2006:347)	CLT	2.3.1.4	R. Expose learners to a variety of learning conditions that include a variety of problems and solutions, to be practised in random order. S. Learning tasks should right from the outset provide limited feedback and guidance and be structured in task classes, to provide a holistic view.

Table 3.6: Guidelines for DSDL to promote transfer (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
j. Compare unsolved problems to facilitate analogical retrieval. k. Aim for deep understanding in initial learning contexts.	Kurtz and Loewenstein (2007:338); Chi and VanLehn (2012:180); Perkins and Salomon (2012:252); Schwartz <i>et al.</i> (2011:772)	Transfer	2.2.3.1.1 2.2.3.2	
l. Use collaborative learning to provide more processing capacity to the WM and increase the transferability of knowledge and skills. m. Provide opportunities for discourse within groups, in order for students to share the different aspects of scenarios that they notice.	Choi <i>et al.</i> (2014:225); Kirschner <i>et al.</i> (2009b:311, 314); Kirschner <i>et al.</i> (2018:220); Van Merriënboer <i>et al.</i> (2006:349-350); Zhang <i>et al.</i> (2016:171)	CLT	2.3.1.3	H. Apply constructive controversy in CL.
	Lobato <i>et al.</i> (2012:476)	Transfer	2.2.3.1.2	
	Johnson and Johnson (2014:842)	CL	2.3.1.2	
n. Incorporate sense-making and satisficing. Sense-making: To determine if task goals have been accomplished, continuously evaluate the solution to determine if it satisfies the goals, in order to decide if the transfer process should stop or should continue. Satisficing: Generate a solution to accomplish certain goals. o. Give feedback on overzealous transfer, assisting students to seek simpler solutions.	Belenky and Nokes-Malach (2012:400); Nokes-Malach and Mestre (2013:188); Schwartz <i>et al.</i> (2012:206)	Transfer	2.2.3.1.1 2.2.3.1.3	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements. K. Focus on the element of group processing. T. Give feedback on overzealous transfer during group processing – ask “Is this the most effective solution?”
	Johnson <i>et al.</i> (2008:1:14-1:15)	CL	2.3.1.1.5	

Table 3.6 : Guidelines for DSDL to promote transfer (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
p. The model of instruction is a large contributor to transfer. q. When students first explore novel deep structures and are only told afterwards what experts or teachers know, transfer is improved.	Schwartz <i>et al.</i> (2011:770, 772); Felder and Brent (2007:39); Johnson and Johnson (2017:287); Pai <i>et al.</i> (2015:79)	Transfer	2.3.2.4	
r. Let students design their own scenarios. s. Allow learners more control over learning content that needs to be studied. t. Opportunities to practise skills should be provided, including error management and how to anticipate and handle problem situations in realistic, positive and negative environments. u. Include authentic activities.	Grossman and Salas (2011:107); Herrington and Herrington (2006:3-6); Taylor <i>et al.</i> (2005:694) Mentz <i>et al.</i> (2008:259); Williams and Kessler (2003:3); Wray (2010:51) Gureckis and Markant (2012:464)	Transfer CL SDL	2.2.3.2 2.4.1.3 3.3.1.1	U. Provide opportunities for learners to design their own scenarios. V. Include authentic tasks and real-life problems.
v. Aim for mastery-approach goals, such as focusing on developing competence and attaining skills, rather than performance goals.	Belenky and Nokes-Malach (2012:400)	Transfer	2.2.3.1 2.2.3.2	W. Aim for mastery-approach goals, such as focusing on developing competence and attaining skills, rather than performance goals. D. Focus on the element of positive interdependence.

Table 3.7: Guidelines for DSDL that support cognitive load theory

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. Restructure course content for a more holistic approach. Sequence topics to assist schema construction, provide suitable worked-out examples, distribute core concepts throughout the topics, and focus on the underlying purpose of concepts in theory and practice. b. Follow a whole-part approach for learning tasks, and order learning tasks in task classes. From the first task class, whole and meaningful tasks should be given in order for learners to develop a holistic view of the whole task. Each subsequent task should then be more complex and should require more knowledge than the preceding simpler task class. The “scaffolding” of tasks will thus take place within the element interactivity of the task classes, as earlier task classes will have lower element interactivity than subsequent task classes. From the outset, learners’ attention should be focused on those elements that are most important for learning. c. Integrate content in the WM with existing schemas in the LTM. d. Constantly rehearse new material to be held in the WM indefinitely, to facilitate transfer to the LTM. e. Acquire a large knowledge base in the LTM. f. Improve and manage WM resources, and reduce unnecessary load on the WM.	Choi <i>et al.</i> (2014:225-226); Mason <i>et al.</i> (2016:84); Paas <i>et al.</i> (2010:116-117); Sweller <i>et al.</i> (2011:43-44); Van Merriënboer and Kirschner (2018:5); Van Merriënboer <i>et al.</i> (2006:349)	CLT	2.3.1.1 2.3.1.3 2.3.1.4	X. Restructure course content for a holistic approach. Sequence topics to assist schema construction. Distribute core concepts throughout the topics, and focus on the underlying purpose of concepts in theory and practice. Restructure course material to revise new material. Provide an overview, and each time revisit topics at a deeper level. Y. When organising topics, provide repeated experience with the same information but in different contexts. Z. Follow a whole-part approach for learning tasks, and order learning tasks in task classes. From the first task class, whole and meaningful tasks should be given in order for learners to develop a holistic view of the whole task. Each subsequent task should then be more complex and should require more knowledge than the preceding simpler task class.

Table 3.7: Guidelines for DSDL that support cognitive load theory (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
g. Reduce the intrinsic cognitive load and the extraneous cognitive load of learning complex tasks in the early phases of training. Limit feedback and guidance to provide learners with opportunities to monitor internal processes and make cognitive representations of how different aspects of the task interact.	Könings <i>et al.</i> (2019:86); Paas and Van Gog (2006:90); Paas <i>et al.</i> (2010:117); Perkins and Salomon (2012:257); Sweller <i>et al.</i> (2011:45); Van Merriënboer and Kirschner (2018:71-81); Van Merriënboer <i>et al.</i> (2006:349-350); Waris <i>et al.</i> (2015:1)	Transfer	2.3.1.1 2.3.1.3 2.3.1.4	All guidelines as indicated above in Table 3.7 also apply to this section of the table. AA. Study worked-out examples at the initial stage when working on complex tasks, to reduce the extraneous cognitive load. As learner expertise increases, replace worked-out examples with partially completed examples, until ultimately only providing learners with complex tasks. AB. Compare and contrast examples to identify deep-structure similarities. AC. Expose learners to a variety of learning conditions that include a variety of problems and solutions, to be practised in random order.
h. The extraneous cognitive load should be kept as low as possible, especially when complex content or difficult problems are involved.	Choi <i>et al.</i> (2014:227); Kalyuga (2011:15); Sweller <i>et al.</i> (2011:57); Van Merriënboer <i>et al.</i> (2006:343)	CLT	2.2.2.1.1 2.2.1.3	
i. Study worked-out examples at the initial stage when working on complex tasks, to reduce the extraneous cognitive load. As learner expertise increases, replace worked-out examples with partially completed examples, until ultimately only providing learners with complex tasks.	Kalyuga (2009:333); Könings <i>et al.</i> (2019:86); Paas and Van Gog (2006:90); Van Merriënboer <i>et al.</i> (2006:348); Van Merriënboer and Kirschner (2018:71)	CLT CL Transfer	2.2.1.3	
j. Compare and contrast examples to identify deep-structure similarities. k. Expose learners to a variety of learning conditions and a variety of problems and solutions, to be practised in random order. Key ideas will then be retrieved in multiple ways, which will enhance schemas in the LTM.	Halpern and Hakel (2003:39); Hatala <i>et al.</i> (2003:25); Kurtz and Loewenstein (2007:334); Norman (2009:809); Schwartz <i>et al.</i> (2012:208); Van Merriënboer <i>et al.</i> (2006:346)	CLT CL Transfer	2.3.1.4	

Table 3.7: Guidelines for DSDL that support cognitive load theory (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
l. Guide students through inquiry activities first and do some problem-solving, instead of following a tell-first approach.	Schwartz <i>et al.</i> (2012:210)	CLT	2.3.1.4	A. Apply CL or cooperative pair programming as a teaching strategy, supported by the five essential elements.
m. Use collaborative learning to provide more processing capacity to the WM and increase the transferability of knowledge and skills.	Choi <i>et al.</i> (2014:225); Kirschner <i>et al.</i> (2009b:311, 314);	CLT Transfer	2.3.1.3	J. Assign complementary roles to group members, or the roles of driver and navigator in cooperative pair programming.
n. Group tasks must have an appropriate level of complexity to encourage group interdependence.	Kirschner <i>et al.</i> (2018:220); Van Merriënboer <i>et al.</i> (2006:349-350);			D. Focus on the element of positive interdependence.
o. Group members should be dependent on each other and should be communicating and coordinating their knowledge.	Zhang <i>et al.</i> (2016:171)			C. Incorporate complex tasks.
p. Tasks should be concrete and authentic.	John-Steiner and Souberman (1978:126);	SCT	2.3.2	V. Include authentic tasks and real-life problems.
q. Learner characteristics, learning-task characteristics, and the physical environment influence cognitive load and should be taken into account.	Murphy <i>et al.</i> (2005:342); Thomas <i>et al.</i> (2014:2); Vygotsky (1978:78)			AD. Guide students through inquiry activities first and do some problem-solving, instead of following a tell-first approach.
r. Heterogeneous groups can be more effective for learners with lower levels of prior knowledge than both homogeneous groups and individual learning. No implications for learners with high levels of prior knowledge were reported for heterogeneous groups.	Felder and Brent (2007:40); Gillies (2014:133); Janssen <i>et al.</i> (2010:149); Johnson and Johnson (2014:843); Pai <i>et al.</i> (2015:82); Slavin (2013:184)	CL Transfer	2.3.1.3 2.4.1 2.4.1.2 2.4.1.1 2.4.2 2.4.3	AE. The composition of groups should be heterogeneous. Group members must be allocated by the facilitator on a random basis.
s. Make use of collaboration scripts, to guide inexperienced groups on working together.	Fischer <i>et al.</i> (2013:64)	CLT	2.3.1.3	AF. Introduce collaboration scripts to inexperienced groups initially. Care should be taken not to allow collaboration scripts to distract learners' attention and thus limit deep processing of content.

Table 3.8: Guidelines for DSDL that support social constructivist theory

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION	TEACHING STRATEGY WITHIN A COOPERATIVE LEARNING ENVIRONMENT
a. By collaborating with peers, learners can master concepts earlier than they would have on their own.	Vygotsky (1978:86)	SCT	2.3.2	A. Apply CL or cooperative pair programming as a teaching-learning strategy, and include the five essential elements.
b. Students should engage actively in exchanging ideas and meaning negotiation, by looking at and reflecting on the multiple perspectives of fellow students. c. Peers learn from each other by sharing ideas, compromise willingly, make mutual plans, and are open to each other's insights. d. Students learn by being exposed to the perspectives of their peers, which clarifies their ideas and thus fosters application of the material that has been learnt. e. Expose learners to multiple views or insights on a specific concept in order to obtain a deeper understanding and enhance transfer.	Damon (1984:333); Murphy <i>et al.</i> (2005:342); Stearns (2017:72)	SCT Transfer	2.3.2	

In tables 3.2 to 3.8, guidelines were given to develop DSDL in a cooperative learning environment. Cooperative learning and thus cooperative pair programming have already been motivated as possible teaching-learning strategies to foster DSDL (see section 3.5). Table 3.9 will therefore focus specifically on providing guidelines for cooperative learning and cooperative pair programming as teaching-learning strategies to develop DSDL. As the success of cooperative learning revolves around five specific elements (see section 2.4.1.1), these elements will be indicated in bold in Table 3.9. If a guideline also fosters another concept or theory, such as transfer or CLT, it is indicated in the respective column in Table 3.9. The sources where the guidelines were obtained from and the numbers of the sections where the guidelines were discussed in the thesis are also indicated in Table 3.9.

Table 3.9: Guidelines for cooperative learning and cooperative pair programming to develop DSDL

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION
The mere placing of students in groups and requiring them to work together does not necessarily promote cooperation and have the desired learning outcomes.	Baloche and Brody (2017:276); Gillies (2014:129); Johnson and Johnson (217:284)	CL	2.4
- Interactions among group members will increase student achievement, due to mental processing of information. - Provide opportunities to discuss, to argue, to present, and to hear the views of others.	Slavin (2013:184)	CL	2.4.1
	Berger & Hänze (2015:310); Kirschner <i>et al.</i> (2009a:31); Kirschner <i>et al.</i> (2018:220)	CLT	2.4.2.1 2.3.1.3
	Stearns (2017:72)	SCT Transfer	2.3.2
Incorporate all five elements of cooperative learning, namely positive interdependence, individual accountability, promotive interaction, social skills, and group processing.	Johnson and Johnson (2017:284)	CL	2.4.1.1
Incorporate positive interdependence, by incorporating goal interdependence, joint rewards, divided resources, complementary roles, a shared identity, and task interdependence, or by allocating complex tasks to groups. Individuals should have the view that the work they are doing mutually benefits each other.	Bertucci <i>et al.</i> (2016:97); Johnson and Johnson (2017:286); Kirschner <i>et al.</i> (2011:622); Pai <i>et al.</i> (2015:81); Slavin (2013:190)	CL	2.4.1.1.1
Incorporate individual accountability. Each group member should accept the responsibility to complete their part of the task and to master the material that has to be learnt.	Bertucci <i>et al.</i> (2016:103); Felder and Brent (2007:35); Gillies (2014:130); Johnson and Johnson (2017:286); Johnson <i>et al.</i> (2008:1:14); Slavin (2013:187)	CL DL	2.4.1.1.2
Incorporate face-to-face promotive interaction. - Group members have to share resources and encourage each other by supporting and critically evaluating each other's learning efforts. - Group members should listen to each other, provide constructive feedback, exchange ideas, and challenge reasoning and conclusions. Promotive interaction will exist when group members praise each other's efforts and assist, teach, support and encourage each other.	Felder and Brent (2007:35); Gillies (2014:131); Johnson and Johnson (2017:286); Johnson <i>et al.</i> (2008:1:14)	CL SCT	2.4.1.1.3

Table 3.9: Guidelines for cooperative learning and cooperative pair programming to develop DSDL (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION
• Foster social skills. • Do not assume that learners will have the necessary social skills required to work in cooperative groups. First create a climate to foster willingness to cooperate, asking for help and handling conflicts.	Buchs and Butera (2015:212); Felder and Brent (2007:41-42); Johnson and Johnson (2017:286); Johnson <i>et al.</i> (2008:1:14-1:15); Gillies (2014:130)	CL SCT	2.4.1.1.4
• Incorporate group processing. The full benefits of cooperative learning will not be reaped if this element is left out. • Groups have to reflect on and discuss how well they have achieved their goals, and which behaviours need to change in order to improve the group's performance. Ask questions, for example what they have been doing well, what needs improvement, and what they will do differently next time. • The following skills are mentioned for enhancing group interactions: active listening, considering each other's ideas and perspectives, stating ideas clearly without making degrading comments, accepting responsibility for behaviour, constructive critique of ideas, sharing of resources, taking turns, and social skills of leadership, decision-making, trust-building, communication, and conflict management. • Group members are expected to show appreciation and respect for each other's contributions, which tends to increase members' self-esteem. • When engaging in group processing and receiving feedback, group members are being made more aware of their thinking about the topic being discussed, and they are provided with insight into how to behave more effectively and how to improve their social skills when interacting with others. • When giving feedback skilfully, the focus is directed towards constructive action, and group members are empowered to be more effective in future.	Felder and Brent (2007:42); Gillies (2014:130); Johnson and Johnson (2009:369); Johnson and Johnson (2017:286); Johnson <i>et al.</i> (2008:1:14); Johnson <i>et al.</i> (2008:7:5)	CL	2.4.1.1.5

Table 3.9: Guidelines for cooperative learning and cooperative pair programming to develop DSDL (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION
- Limit groups to four or fewer members. - Preferably the facilitator must allocate group members. - Diverse personalities in groups can be united by incorporating a high level of positive interdependence, creating mutual goals, developing common ground, and creating a group identity. - An effective way to assign students to a group is by using a random method. Creative group allocation can be seen as an icebreaker and as providing common ground for heterogeneous groups, for example by asking students to write down their favourite sports team or vegetable and then asking them to find students who have the same preference. - Learners can work in formal, informal or cooperative base groups.	Felder and Brent (2007:40); Gillies (2014:133); Johnson and Johnson (2013:486, 469); Johnson and Johnson (2014:841-842)	CL	2.4.1.2
CL will work even better if learners are faced with complex tasks and challenging problems, as students normally resent working in groups on easy tasks that they could have completed on their own.	Felder and Brent (2007:42)		
- Include constructive controversy. - During constructive controversy deliberate discourse scenarios are created, to encourage group members to disagree and to elaborate on arguments, to ultimately reach agreement or a decision. - When group members engage in discourse, critique and challenge each other's views, and are able to come to mutual agreements, the following benefits are derived: development of creativity, critical thinking, improved transfer, higher reasoning levels and metacognition, improved motivation to learn about the issue at hand, improved interpersonal attraction, and social support and social competence among participants.	Johnson and Johnson (2013:318); Johnson and Johnson (2013:320); Johnson and Johnson (2014:842); Popov <i>et al.</i> (2017:426)	CL DL Transfer SCT	2.4.1.2

Table 3.9: Guidelines for cooperative learning and cooperative pair programming to develop DSDL (cont.)

GUIDELINE	SOURCE	CONCEPT OR THEORY	SECTION
• Embed the five elements of cooperative learning in pair programming, which is then referred to as cooperative pair programming. • Apply cooperative pair programming, where two learners work together side by side on one computer and collaborate to solve a problem. • The roles of “driver” and “navigator” are allocated to the pair. The driver has to operate the computer, type in commands, or write a design. The navigator is described as the strategic, long-range thinker, who asks the driver questions, for example to explain what they are doing, checks for errors, observes what the driver is doing, and asks appropriate questions to ensure that the driver is on the right path. The driver and the navigator can also at any time engage in brainstorming activities. • During their problem-solving activity, the driver and the navigator should from time to time swap roles.	Bailey and Mentz (2017:102); Breed <i>et al.</i> (2013:52); Mentz <i>et al.</i> (2008:259); Plonka <i>et al.</i> (2015:77); Sturdy (2005:223); Williams and Kessler (2003:3); Wray (2010:50)	DL Transfer SCT SDL	2.4.1.3

3.7 CONCLUSION

Learning in the 21st century requires that students be deeper learners and self-directed learners, who take ownership of their learning, who can transfer knowledge, and who have a multitude of 21st-century competencies in the cognitive, intrapersonal and interpersonal domains. In this chapter, SDL was described as a process that can be studied by means of the characteristics of self-directed learners, or by the outcomes of enhancing SDL. Comments were made regarding the role of educators in developing and enhancing learners' SDL, and recommendations were offered for creating a climate for SDL in the classroom. It was stated that SDL can be enhanced by applying appropriate teaching-learning strategies. Competencies required for SDL were discussed within the cognitive, intrapersonal and interpersonal domains, to be compared with competencies required for DL.

A discussion followed to determine how DL competencies are related to SDL competencies. It was concluded that overlapping competencies exist between SDL and DL. It was further concluded that SDL and DL as processes should not be reduced and limited by attempting to allocate specific competencies to each. To distinguish these two processes, one should rather look at the outcomes and aims of each individual process, to indicate how they are interrelated in determining DSDL.

Lastly, DSDL was described as a process that revolves around cognitive, intrapersonal and interpersonal competencies, driven by SDL and DL. The competencies as indicated in Table 3.1 are therefore also indicated as required for DSDL. It was further argued that none of the processes of SDL and DL can be excluded when teaching and learning in the 21st century. It was further stated that DSDL can meet the requirements of 21st-century learning. When DSDL is incorporated into teaching and learning strategies, students will take responsibility for their learning, where the aim is for them to transfer their knowledge to new and unknown situations. Students will view their learning needs in terms of such transferable knowledge, they will formulate their goals accordingly, they will identify resources and collaborate with others, they will apply critical thinking, they will solve problems, they will evaluate whether appropriate learning goals and transfer of knowledge have been achieved, and they will persist in their learning until their goals have been met.

By defining DSDL, and providing a theoretical basis for DSDL, research aim 1 has been achieved. From this theoretical basis, guidelines for instructional practices to develop DSDL were given, thus achieving research aim 2. Cooperative learning and cooperative pair programming were proposed as possible teaching-learning strategies to develop DSDL. When applying these as teaching-learning strategies, the aim will accordingly be to instil lifelong learning and develop deeper self-directed learners, who can successfully face the challenges of

the 21st century. Finally, it was indicated how the suggested guidelines can be implemented in a CL environment, thereby answering research question 3.

In chapter 4, the research design and methodology of this study will be discussed, indicating how the implications of implementing the suggested guidelines were determined.

CHAPTER 4:

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

In chapters 2 and 3 a literature review on deeper learning (DL) and self-directed learning (SDL) was done in order to define the term “deeper self-directed learning (DSDL)” and to provide a theoretical basis for DSDL. Guidelines for instructional practices to develop DSDL were suggested from the literature review. In this chapter the research design for developing DSDL will be discussed. Design research was applied as the research methodology, that incorporated an embedded mixed methods design which combined convergent and explanatory sequential mixed methods approaches. It will be indicated how the research aims were addressed through the different phases of design research. To determine the implications of the suggested guidelines for developing DSDL, the focus was on research aim 4 and the following research sub-aims:

- 4a. To determine students’ experiences of implementation of the suggested guidelines;
- 4b. To determine the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills;
- 4c. To determine the factors that hindered or promoted transfer; and
- 4d. To determine the effect of deliberate implementation of the suggested guidelines on students’ SDL.

Each of the four research sub-aims required specific approaches for data collection and analysis, which thus determined the choice of research design. The order of the discussion will be to explain the research design and methodology, by discussing the research paradigm, design research and mixed methods research, the population and sampling, the data collection methods, and analysis of the data. Lastly, the reliability and validity of the research will be discussed, followed by a discussion of ethical issues.

4.2 RESEARCH METHODOLOGY

This research was conducted from a pragmatic paradigm. Design research was applied as the research methodology, incorporating an embedded mixed methods research design which combined convergent and explanatory sequential mixed approaches. In the following section the pragmatic paradigm will be explained, and a rationale will be given for doing research from a pragmatic paradigm.

4.2.1 Pragmatic paradigm

A paradigm is defined by Creswell (2014:6) as a researcher's "general philosophical orientation about the world and the nature of research that a researcher brings to a study". Research from a pragmatic paradigm will therefore be conducted for reasons likely to be influenced by the values and beliefs of the researcher (Coe, 2012:8). A researcher's preferred paradigm influences how they select their research questions and which approaches and methods they will use in providing answers to the research questions (Morgan, 2007:49). As viewed by Shannon-Baker (2016:321), paradigms can be seen as guides that researchers use to ground their research.

Teddlie and Tashakkori (2003:21) mention a few characteristics of pragmatism. In the first place, pragmatism supports the use of both quantitative and qualitative research methods in the same research study and within multistage research. Pragmatists will thus use all possible data collection methods (Maxcy, 2003:12) and approaches necessary to best meet the needs of the research (Creswell, 2014:10-11). According to Shannon-Baker (2016:322), pragmatists want to provide optimal, practical solutions to problems. Green (2000:128) argues that complex problems can only be solved by using various data collection methods, thus implying a pragmatic view.

Secondly, Teddlie and Tashakkori (2003:21) state that when approaching research from a pragmatic view, the research aims and objectives are seen as more important than the methods used. According to Biesta (2010:103), the focus should be on the purpose of the research, which will then determine the research questions. Thus, when doing research from a pragmatic paradigm, a researcher focuses on the research problem, rather than focusing on using a specific approach (Creswell, 2014:10). From the research problem the research questions are developed, and based thereon, various research methods are selected.

Biesta (2010:112) claims that pragmatism should not be seen as a combination of other research paradigms due to the use of various research methods. Pragmatism should rather be seen as having a purpose of its own, namely to explain (Biesta, 2010:112). According to Biesta (2010:112), the main orientation of explanation is to identify causes, or to find correlations between events. In this regard, Green (2000:128) is of the opinion that by obtaining explanatory insights into research problems, shortcomings of other approaches that, for example, believe in a single reality, or aim to understand (Biesta, 2010:104), can be overcome. However, in a social context, and thus when doing research on teaching and learning, the pragmatic view can become intertwined with other approaches (Biesta, 2010:104), as the link between teaching and learning is often established through interpretation or understanding of explanatory research (Biesta, 2010:104).

Thirdly, Teddlie and Tashakkori (2003:21) are of the opinion that pragmatism presents a practical and applied research philosophy. Research is viewed as a process through which knowledge is generated (Biesta, 2010:101), and new theories are thus formed. Pragmatists are of the opinion that theories are contextual, but also generalisable to other situations (Shannon-Baker, 2016:322). From a pragmatic view, knowledge is obtained through a “combination of action and reflection” (Biesta, 2010:112), therefore implying practical and applied research. Interventions are typically applied (Shannon-Baker, 2016:323), and the consequences of these interventions on a phenomenon are observed (Biesta, 2010:112). According to Biesta (2010:101), the relationships between the interventions and the consequences thereof shape knowledge.

When doing research on teaching and learning, Middleton *et al.* (2008:29) suggest that educational interventions should be done “in a lifelike way”. They therefore propose that a pragmatic approach should be taken (Middleton *et al.*, 2008:29). Middleton *et al.* (2008:29) explain that educational settings have a variety of variables that can influence the outcome of interventions, such as the degree of enthusiasm of the teachers. Therefore, the aim in educational research should be on creating realistic settings in which interventions can be made (Middleton *et al.*, 2008:29). In taking such an approach, standardisation is sacrificed for realism, and a variety of in-depth procedures are required to collect and analyse data to obtain the effect of interventions (Middleton *et al.*, 2008:29). Therefore, with a pragmatic approach, an “unbiased estimate of the average effect of the intervention” (Middleton *et al.*, 2008:29) can be obtained, with additional information on external factors that have increased or reduced the effect (Middleton *et al.*, 2008:29).

In this section a rationale was given for doing this research from a pragmatic paradigm. It was indicated that a pragmatic view is proposed when doing research on teaching and learning when interventions are applied in real-life settings.

In this study, the research was guided by multiple research questions (see section 1.3). The researcher aimed to answer the research questions, and thus achieve the research sub-aims (see section 4.1), by providing optimal, practical solutions to complex problems. A process of action and reflection was followed, by developing interventions and observing the consequences of the interventions. I wanted to observe the effect of the interventions within realistic settings, using various data collection methods. From comparing the relationships between the consequences of the interventions and identifying causes and correlations between events, explanatory insights into the research problem were obtained. Thus, new knowledge on DSDL and the factors related to enhancement thereof could be created.

In the following section, design research, which was applied as the research methodology in view of the pragmatic paradigm, will be discussed.

4.2.2 Design research

In this section a rationale will be provided for using design research as the research methodology in this study. A generic model of design research will first be discussed. Thereafter a rationale for applying design research in education will be given. Lastly, it will be indicated that design research is a suitable methodology for the research to develop DSDL, and this will be followed by a detailed explanation of the design.

Design research is described as a “complex endeavour” (McKenney & Reeves, 2012:1; Middleton *et al.*, 2008:21) consisting of multiple facets (McKenney & Reeves, 2012:1). Design research is characterised as having an approach of “progressive refinement” (Collins *et al.*, 2004:18). Products and systems need to be designed that solve problems of importance to society (Middleton *et al.*, 2008:21). Initially a first version of the design is implemented and evaluated. The design is then revised and refined until the design is virtually error-free (Collins *et al.*, 2004:19). This iterative cycle of applying an intervention, determining the effect of the intervention, and adjusting the intervention for the following implementation is described as a “multistage model of design research” (Lobato, 2008:187).

Design research is not only aimed at refining practice, but “should also address theoretical questions and issues” (Collins *et al.*, 2004:19). Therefore, in order to determine the form and function of a design, the epistemological basis on which a design is built should be determined (Middleton *et al.*, 2008:35). The epistemological basis can be explained as the basis of how knowledge is obtained (O’Toole & Beckett, 2013:37), to thus address theoretical questions and issues. Due to the complexity of design research, various methodological approaches will have to be adopted to obtain knowledge (Cobb & Gravemeijer, 2008:68).

4.2.2.1 The complete design research cycle

Middleton *et al.* (2008:32-41) describe the complete design research cycle, which can be considered the blueprint of design research models. The complete design research cycle typically consists of seven phases (Middleton *et al.*, 2008:32) and is depicted in Figure 4.1. This cycle as described by Middleton *et al.* (2008:27-31) will be elaborated on in the following paragraphs.

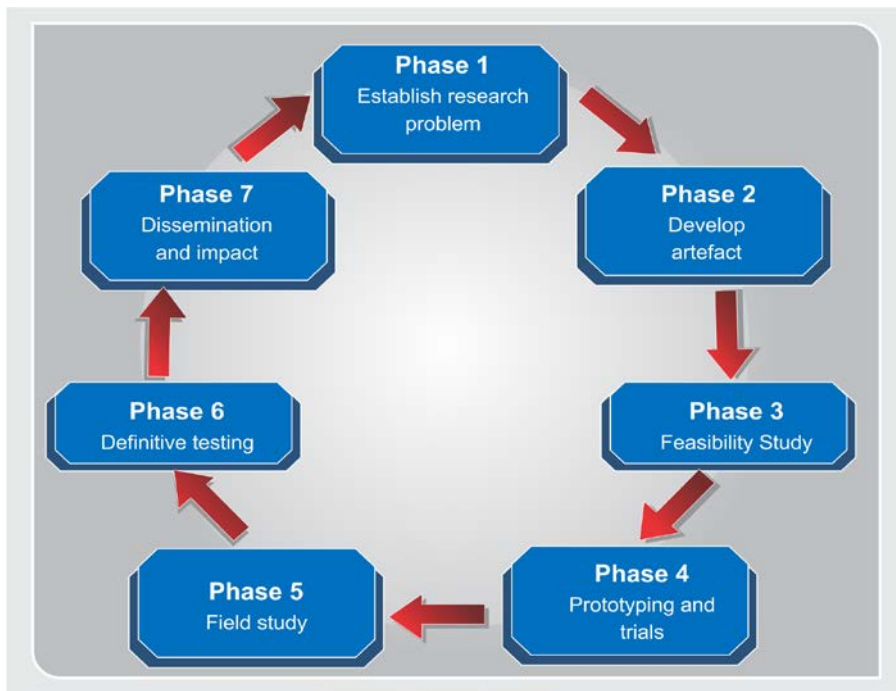


Figure 4.1: The complete design research cycle (Middleton *et al.*, 2008:32)

The first phase of the complete design research cycle establishes the research problem or issue that needs to be addressed (Middleton *et al.*, 2008:27). Phase 2 involves the development of a testable intervention or artefact, and it can be described as “the most creative phase of the research sequence” (Middleton *et al.*, 2008:27). The designed artefact or intervention should be testable against predetermined criteria, for “scientific inquiry to continue” (Middleton *et al.*, 2008:27). In phase 3, the feasibility of the research, especially with regard to a time frame and expenses, is determined (Middleton *et al.*, 2008:33). A theoretical justification for the research needs to be presented, and the roles of all parties involved, researchers, participants and authorities have to be negotiated (Middleton *et al.*, 2008:33, 34).

Phases 4 and 5 are characterised by iterative processes. Phase 4 involves prototyping and the development of an initial intervention model. According to Middleton *et al.* (2008:31), phase 4 is typically characterised by piloting small-scale prototypes and trials of the intervention (Middleton *et al.*, 2008:31). After prototyping on a small scale, the intervention can be implemented on a larger scale, in phase 5. This phase can therefore also be described as the “field study” phase (Middleton *et al.*, 2008:31). In phase 5, the intervention is implemented in full, and it is tested and modified. Again, this is an iterative process, which continues until a series of objectives has been met and a model that can be implemented in various contexts has been developed (Middleton *et al.*, 2008:31). Systematic documentation and recordings about the intervention and the process of implementation are important requirements at this stage (Middleton *et al.*, 2008:31).

After the field study phase, the intervention can be definitively trialled to ensure the effectiveness thereof. Phase 6 is thus described as the “definitive trial or evaluation” phase (Middleton *et al.*, 2008:31). Although Figure 4.1 indicates an infinite cycle of theory building, designing, and testing, results have to be disseminated at some stage. In phase 7, the findings are accordingly made available to the community. The findings need to indicate how the intervention or artefact has worked, and they need to provide other practitioners and policymakers with information to determine if the intervention or artefact can be implemented in the real world. Therefore, Middleton *et al.* (2008:28) suggest that by phase 7 of the research, the intervention should be “transportable to other contexts or situations”. The new knowledge generated by the research must also be able to contribute to future developments. As stated by Middleton *et al.* (2008:26), typical to design research, the emerging intervention applied in the final phase should not be seen as an “ultimate solution”, and it will continue to evolve.

Although design research was initially more associated with sciences such as engineering (Collins *et al.*, 2004:17), it has in recent years been established as a practical research methodology in education (Anderson & Shattuck, 2012:16). In the following section, design research for educational settings will be discussed.

4.2.2.2 *Design research for education*

According to Anderson and Shattuck (2012:16), design research in educational contexts has evolved since the beginning of the 21st century. They further state that design research is considered a practical research methodology to bridge the gap between research and practice in education (Anderson & Shattuck, 2012:16). Researchers accordingly agree that design research addresses theoretical and practical issues central to the study of learning (Cobb & Gravemeijer, 2008:68; Collins *et al.*, 2004:16; McKenney & Reeves, 2012:63). Examples of such issues are theoretical questions about the nature of learning in context, to study learning phenomena in the real world, to define theory and practice, to go beyond narrow measures of learning (Collins *et al.*, 2004:16, 19), to do research on transfer of learning (Lobato, 2008:190; McKenney & Reeves, 2012:105), and to develop new curricula (Middleton *et al.*, 2008:25).

According to Cobb and Gravemeijer (2008:68), design research in education can be defined as “a family of methodological approaches in which instructional design and research are interdependent”. To McKenney and Reeves (2012:7), educational design research involves “iterative development of solutions to practical and complex educational problems”. The design of the learning environment is seen as the context of the research, and retrospective analyses of the design “inform the improvement of the design” (Cobb & Gravemeijer, 2008:68). Theoretical understandings that can inform further research are thus produced (McKenney & Reeves, 2012:7). As explained in section 4.2.1, design research in education has a “strong

pragmatic orientation” (Cobb & Gravemeijer, 2008:72). Two reasons that can be given for this is that the goal of design research is to produce knowledge that can provide guidance on how to support specific learning processes, and design research is based on various methodological approaches (Cobb & Gravemeijer, 2008:72).

Design research in educational contexts, however, poses many challenges (Collins *et al.*, 2004:16). Firstly, research is done in real-world situations, where experimental control is limited (Collins *et al.*, 2004:16; Middleton *et al.*, 2008:29). Thus, in-depth data collection using a variety of methods is required to compensate for the lack of experimental conditions (Middleton *et al.*, 2008:29). Furthermore, designs in educational settings cannot be completely specified (Collins *et al.*, 2004:17), due to the existence of too many variables (Middleton *et al.*, 2008:28). Also, because of the character and the complexity of design research, various methodological approaches are required, as already indicated above, resulting in a large amount of data that needs to be analysed and integrated (Collins *et al.*, 2004:16).

Educational research is often limited by time. It is thus questionable whether design research is suitable for short-term projects in educational settings. Pool and Laubscher (2016:9), however, argue that the principal outcomes of design research can still be achieved with short-term projects, despite the limitation of having a restricted number of cycles for implementation. Educational research furthermore does not require the collecting of extensive information on why changes happened before interventions were implemented (Middleton *et al.*, 2008:26). Therefore, design research for educational settings typically consists of fewer phases than those indicated in the complete design research cycle (see Figure 4.1).

Researchers have made various proposals for design research models for educational settings. Cobb and Gravemeijer (2008:68) propose a simplified model for design research in education, consisting of only three phases: preparing for the research intervention (phase 1), executing the intervention (phase 2), and analysing the data retrospectively (phase 3). Middleton *et al.* (2008:27-28) propose a four-phase model of research in education (see Figure 4.2), thus with three fewer phases than the complete design research cycle (see Figure 4.1).

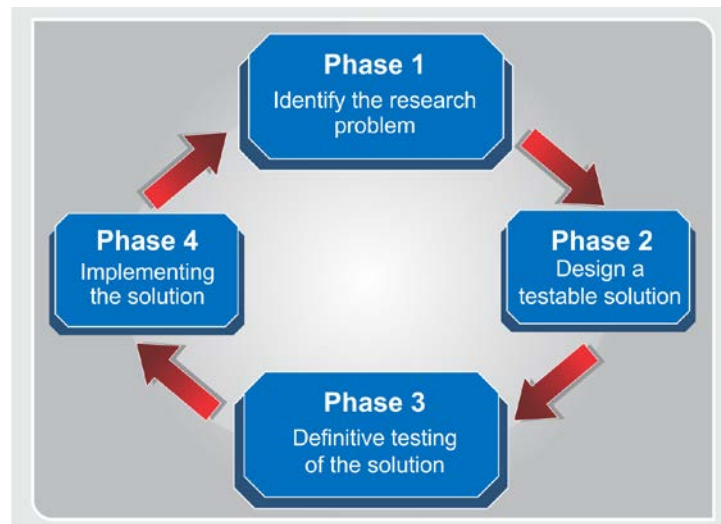


Figure 4.2: Basic model for design research in education (Middleton *et al.*, 2008:28)

In the proposed basic model for design research in education, as indicated in Figure 4.2, the first two phases are similar to phases 1 and 2 of the complete design research cycle (see Figure 4.1). In phase 1 the research problem is identified, and this phase involves the developing of an artefact or a testable solution (an intervention). However, in the model for education, phases 3 to 5 of the complete design research model are condensed to only one phase, namely phase 3. Prototyping on a small sample of the population and conducting a field study are not typical of educational design research (McKenney & Reeves, 2012:125). Therefore, after designing a testable solution, phase 3 involves implementation of a trial or an intervention. Evaluation of this phase should indicate if the intervention was more effective than other pedagogical practices (Middleton *et al.*, 2008:28). It is further suggested that phase 3 should include a control group and an intervention group, to ensure a definitive test (Middleton *et al.*, 2008:28). In the last phase, phase 4, the results of the definitive test are made known to the teaching and learning community.

Figure 4.3 shows a generic model for conducting design research in education, proposed by McKenney and Reeves (2012:77), which indicates their view of the essential phases and elements of design research in education.

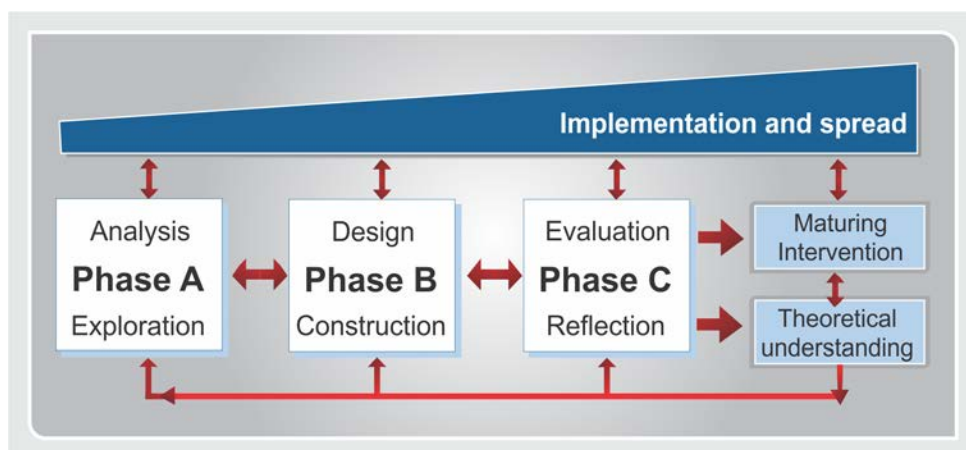


Figure 4.3: Generic model for conducting design research in education (McKenney & Reeves, 2012:77)

For the sake of clarity, the phases described by McKenney and Reeves (2012:77) have been renamed as phases A, B and C for this discussion. McKenney and Reeves (2012:77) view design research in education as consisting of three core phases: analysis and exploration (phase A), design and construction (phase B), and evaluation and reflection (phase C). Although the articulated descriptions of the phases differ from the phases proposed by Cobb and Gravemeijer (2008:68) and Middleton *et al.* (2008:28), the inherent meanings of the phases are similar, as will be explained in the rest of this discussion.

Phase A (see Figure 4.3) consists of an analysis and an exploration part. The main goal of phase A is to define the problem, and the phase consists of three main activities: an initial orientation, a literature review, and a field-based investigation (McKenney & Reeves, 2012:91). A literature review is done to determine the feasibility of the research, to obtain a better and a critical understanding of the problem and the views of other researchers, and to tentatively obtain ideas for data collection (McKenney & Reeves, 2012:93). The purpose of the field-based investigation is to define the problem and to do content analysis and a needs assessment (McKenney & Reeves, 2012:94). In the exploration part of phase A, site visits are recommended, where places are physically visited, as this will ensure that “solutions to educational problems come to life” (McKenney & Reeves, 2012:103).

Phase B consists of a design and a construction part, where in most cases these parts will take place iteratively (McKenney & Reeves, 2012:109). Several interventions will often be applied in this phase, each informed by research and analysis of previous interventions (McKenney & Reeves, 2012:125). Inputs for phase B can come either from phase A or from phase C, as indicated by the arrows in Figure 4.3.

The arrows between the different elements in Figure 4.3 thus indicate the iterative and flexible nature of the design research process, where the process is not limited to a specific sequential

order (McKenney & Reeves, 2012:77). The results of a specific phase or parts of a phase can feed into other elements, over and over again, and many pathways exist for executing the research. The trapezoid in the top section of Figure 4.3 indicates that interaction with practice exists from the start, and that it increases over time. The bidirectional arrows from the trapezoid to the various phases indicate that what occurs in practice influences the phases and the outputs, and vice versa (McKenney & Reeves, 2012:77).

The purpose of phase B is to develop a “well-considered intervention which is grounded in both theory and reality” (McKenney & Reeves, 2012:109). The designing of interventions involves generating various ideas, confirming their feasibility, and selecting the most plausible solution. In the construction part, the solution will be constructed and implemented by a process of prototyping, with each successive implementation being more complete and functional, as informed by analysing the previous design (McKenney & Reeves, 2012:110). The word “prototype” when used in an educational design research context already refers to the intervention applied. In education, a prototype will already be a “planned solution” (McKenney & Reeves, 2012:125). Also, in phase B, the “evolution of ideas” phase, providing a rationale for each intervention should be clearly, systematically and honestly documented (McKenney & Reeves, 2012:111).

Evaluation and reflection, named as phase C, occurs throughout the process of developing a solution to the research problem. The term “evaluation” is used in a broad sense, to refer to all empirical testing of interventions (McKenney & Reeves, 2012:133). Prototyped solutions are accordingly tested, and findings are reflected on to refine “theoretical understanding” and interventions (McKenney & Reeves, 2012:133). According to McKenzie and Reeves (2012:151), the reflection part is concerned with “active and thoughtful consideration” of all research and development during the design research process. They are further of the opinion that new theories are not developed because of research findings, but rather grow out of reflection on theoretical inputs, empirical findings, and subjective reactions (McKenney & Reeves, 2012:151). The last step in the evaluation phase is to report on the study.

According to McKenzie and Reeves (2012:78), design research can be divided into micro-, meso- and macro-cycles. Each of phases A, B and C (see Figure 4.3) include a cycle of action, called a micro-cycle. It has, for example, been mentioned above that phase B is an iterative cycle. It can thus be said that phase B consists of micro-cycles. When two or more micro-cycles are combined, a meso-cycle is formed. The entire research design process is called a macro-cycle. A macro-cycle thus consists of various combinations of meso-cycles, which, in turn, are formed by combinations of micro-cycles. This terminology will again be referred to in section 4.2.2.3, when the design of the research to develop DSDL is discussed.

In this section, educational design research was described, and three generic models for educational design research were discussed. Although the names of the phases as well as the number of phases in the models may differ, all the models inherently explain design research in education in a similar way, but view design research from different perspectives. Design research in education is conducted in real-life settings to find solutions to complex problems, and it has the dual purpose of refining both theory and practice (Collins *et al.*, 2004:19). The research problem has to be analysed, and the feasibility of the study has to be determined. Several prototypes or interventions will be designed and implemented, each time informed by research and analysis of and reflection on the previous design. Thus, theory and practice are refined. The research process can follow any path. The output of each phase informs another phase, or the context of the research, until an intervention is reached that achieves the objectives of the research.

In the following section, design research to develop DSDL will be elucidated.

4.2.2.3 *Design research applied for developing deeper self-directed learning*

In the following section a motivation will first be given for using design research as the methodology in this study to determine how DSDL can be developed in a database and networking module in Computer Applications Technology (CAT) education. Thereafter, the research design applied to develop DSDL will be elaborated on.

4.2.2.3.1 Motivation for applying design research to develop deeper self-directed learning

The characteristics of design research in education, as mentioned in section 4.2.2.2, apply to this research. The first aim of this research was to define DSDL (see section 4.1), addressing a theoretical question about the nature of learning, as indicated by Collins *et al.* (2004:16). The learning phenomenon of DSDL was studied in a real-life application, namely in the CAT education class at a university. Also, from the discussions in chapters 2 and 3, it should be evident that DSDL goes beyond narrow measures of learning. In defining DSDL, the aim was therefore to make a theoretical contribution to the body of literature.

Strategies to foster DSDL had to be developed, analysed and refined to provide practical solutions to the education community. Interventions that could be tested, verified and refined therefore had to be developed. Each time, design responses were informed by the knowledge gained, as suggested by Lobato (2003:18). Design research was therefore applied to obtain the best possible understanding of DSDL, to produce knowledge that can provide guidance on how to develop DSDL, and thus provide practical solutions to the problem statement and the research aims.

In the following section, the research design used to develop DSDL will be discussed according to the generic models for design research in education, indicated in figures 4.2 and 4.3.

4.2.2.3.2 Research to develop DSDL, aligned with the basic model of design research, as proposed by Middleton *et al.* (2008:28)

The research design was multistage, consisting of multiple phases. In Figure 4.4, the phases of the research to develop DSDL are shown in the inner circle. The phases are mapped onto the model for design research in education, as proposed by Middleton *et al.* (2008:28) (see Figure 4.2), indicated in the outer circle.

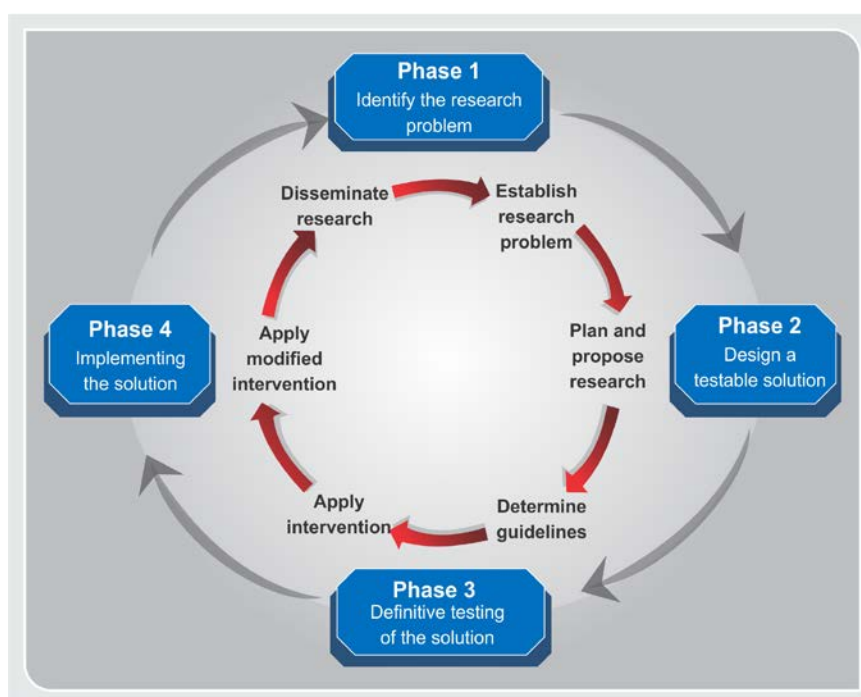


Figure 4.4: Design research to develop DSDL, mapped onto Middleton *et al.* (2008:28)
(Source: own contribution)

In the current study, the research problem was identified and established in phase 1 in the first year of the study, as indicated by Middleton *et al.* (2008:28). The current research had to be tentatively planned and proposed to the relevant committees and authorities. DSDL was defined (research aim 1), and a theoretical model for DSDL was developed by reviewing the literature. The databases consulted were mainly Google Scholar and EBSCOhost. In EBSCOhost, the databases of Academic Search Premier and ERIC were included. Hit words that were mainly used to conduct online searches were “21st-century skills”, “21st-century competencies”, “21st-century learning”, “transfer of learning”, “transfer of knowledge”, “knowledge transfer”, “approaches to learning”, “deeper learning”, “deep learning”, “self-directed

learning”, “cooperative learning”, “collaborative learning”, “cognitive load theory”, “social constructivist theory”, “design research and education”, and “mixed methods research”.

In phase 2 guidelines had to be developed to develop DSDL in the CAT education class at a university (research aim 2). It then had to be determined how the guidelines could be implemented (research aim 3), and a testable solution (an intervention) was developed. The intervention was then implemented in the second year of the study, and the solution could thus be tested, as indicated in phase 3. According to the results obtained by analysing the intervention, the intervention was evaluated, refined and implemented again in the third year of the study. Although no control group was used, as suggested by Middleton *et al.* (2008:28) (see section 4.2.2.2), the refined intervention was applied again to a second group of participants. The aim of implementing, analysing and refining the interventions was to achieve research aim 4 and to revisit research aims 1, 2 and 3 (see section 1.3), as new knowledge was obtained each time.

In phase 4, in the fourth year of the study, the results obtained by all interventions were integrated, and a practical solution to develop DSDL was proposed. The theoretical definition of DSDL was also refined. Finally, the results and the conclusions of the study were reported on, and suggestions were made for transferability to wider educational contexts.

4.2.2.3.3 Research to develop DSDL, aligned with the basic model of design research, as proposed by McKenney and Reeves (2012:77)

The design of the research to develop DSDL will next be aligned with the model as proposed by McKenney and Reeves (2012:77) (see Figure 4.3).

While Figure 4.2 creates the impression of doing design research in successive phases in a sequential order, Figure 4.3 indicates the flexibility of design research, and the notion that no definitive path will be followed when engaging in design research (see section 4.2.2.2). All the phases in design research are interrelated, and the objectives of the research will determine the path followed. Phases A, B and C (see Figure 4.3) as applied in the research to develop DSDL can be summarised as follows:

- Phase A: reviewing the literature, to provide a deeper understanding of the problem, to build a theory for DSDL, and to provide guidelines for instructional practices to develop DSDL;
- Phase B: developing an intervention to develop DSDL, and applying and refining the intervention; and

- Phase C: empirically evaluating the intervention, and reflecting on the design of the intervention.

Table 4.1 shows a timeline of when phases A, B and C were addressed during the four-year period allocated to the research. In the first year of the study, a literature review was conducted, to provide an understanding of the problem and to define DSDL, so as to provide a theoretical underpinning for the study.

In the second year of the study, a prototype of the intervention (McKenney & Reeves, 2012:110) was designed and evaluated. A review of relevant literature continued (phase A), and an intervention to enhance DSDL was developed and implemented (phase B) based on the literature review. In phase C empirical testing was done, and results were evaluated and reflected on. Several cycles of phases B and C were required, while the intervention was constantly refined to develop DSDL. In these cycles, phase A was also addressed, while working towards refining the theoretical understanding of developing DSDL. Accordingly, in the third year of the study, reviewing of the literature continued (phase A). The intervention was refined (phase B), informed by the results obtained from analysing the previous intervention (phase C), and the adjusted intervention was implemented (phase B). Finally, in the fourth year, the results were evaluated, reflected upon and disseminated (phase C).

Table 4.1: Phases in design research to develop DSDL for each year

YEAR 1	YEAR 2	YEAR 3	YEAR 4
Analysis and exploration	Prototype of intervention	Redesign intervention	Evaluate, reflect, and report
Phase A	Phases A, B and C	Phases A, B and C	Phase C

Figure 4.5 shows a meso-cycle (see section 4.2.2.2) of the research design. The meso-cycle consisted of phases A, B and C. One meso-cycle was executed in each of year 2 and year 3 of this study (see Table 4.1). A meso-cycle had to be completed in one semester, and time was limited to 11 weeks – the number of weeks allocated to the database and networking module. Thereafter, another five weeks were allowed for analysing data to inform the following intervention (phase C). Allowing five weeks was possible, because the next meso-cycle could only be conducted in the second semester of the following year, when the module was presented to the next group of students.

A meso-cycle consisted of two intervention cycles, as indicated by the red arrows in Figure 4.5. Each intervention cycle consisted of phases A, B and C, which involved designing and implementing instructional interventions to develop DSDL, followed by data collection methods to determine students' experiences of the interventions and the effect of the interventions on

their DSDL. After evaluating each intervention, adjustments were made to the interventions, informed by the results of the data collection and the literature review. True to the pragmatic paradigm, each intervention cycle required various methods of data collection. These methods will be discussed in section 4.4.

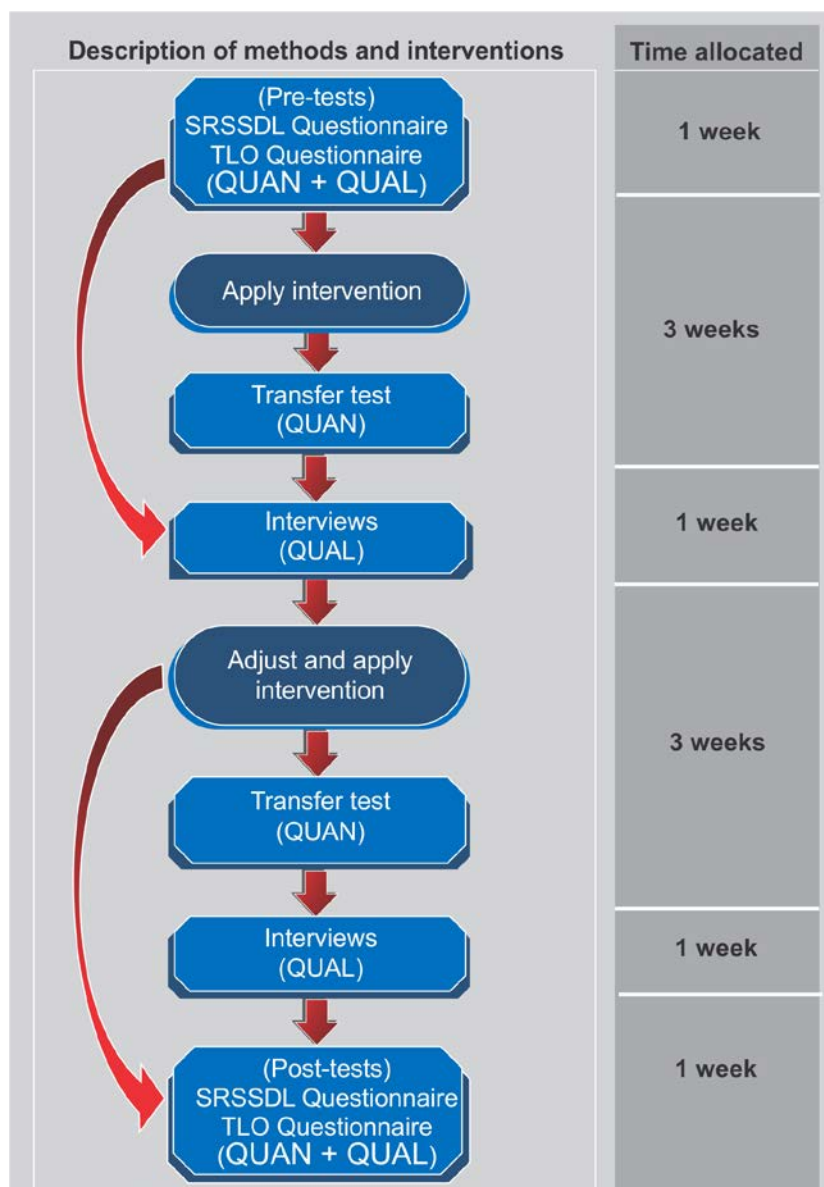


Figure 4.5: One meso-cycle of the design research to develop DSDL
(Source: own contribution)

In this section an explanation was given of the design research applied in the research to develop DSDL. It was also indicated that the research consisted of various intervention cycles. In the following section a more detailed discussion of the intervention cycles is provided.

4.2.2.4 Discussion of the intervention cycles

Based on the literature, guidelines were established to develop DSDL (research aim 2). According to these guidelines, instructional interventions, focusing on fostering DL, transfer,

SDL, and thus DSDL, were developed. These interventions will in the remainder of this chapter be referred to as DSDL interventions. A meso-cycle consisted of two intervention cycles, as indicated in Figure 4.5. Pre-tests to determine participants' perceived SDL and their inclination to transfer (see section 4.4.1.2) were conducted at the start of the first intervention cycle, which was also the start of a meso-cycle.

Each intervention cycle consisted of an intervention and an evaluation and adjustment of the intervention. An intervention to develop DSDL was applied for three weeks. Thereafter an evaluation of the intervention was done by means of empirical testing, to determine students' experiences of the intervention (research aim 4a), the effect of the intervention on transfer (research aim 4b), and the factors that hindered or promoted transfer (research aim 4c). Participants wrote transfer tests (see section 4.4.1.1) and were invited to interviews (see section 4.4.2.1).

Three weeks were allowed for analysing the results of the transfer tests and the interviews and making adjustments to the intervention, after which the second intervention cycle commenced (see Figure 4.5). Allocation of these three weeks was possible because the module had a database and networking component, and the research mainly focused on developing DSDL in the database section. During the three weeks that the results were analysed, the focus shifted to the networking section of the module.

In the second intervention cycle (see Figure 4.5), the adjusted intervention was applied for three weeks. Transfer tests (see section 4.4.1.1) were again written, and participants were invited for interviews (see section 4.4.2.1). Post-tests were conducted at the end of the second intervention cycle, to determine the effect of deliberate implementation of the guidelines on students' SDL (research aim 4d) and their inclination to transfer (research aim 4b). At this stage the end of the meso-cycle was reached. The intervention could thus be reflected on and could be adjusted according to the results obtained.

In the following section the specific details of the guidelines that were applied for each intervention will be discussed.

4.2.2.5 Interventions applied in the research to develop deeper self-directed learning

The interventions that were applied were developed according to the suggested guidelines to develop DSDL (see tables 3.2 to 3.9). Tables 4.2 and 4.3 summarise the interventions that were applied during the first meso-cycle in the second year of the research (MC1) and during the second meso-cycle in the third year of the research (MC2) (see Table 4.1). It is beyond the scope of this chapter to explain the results that implicated the refinement of interventions, and these results will only be elaborated on in chapters 5 and 6.

According to McKenney and Reeves (2012:109), ideas about addressing the problem, and the resulting intervention, will first be broad and vague and without much detail, but will gradually become more refined. The same principle applied when developing the interventions. As suggested by McKenney and Reeves (2012:109), the aim was to develop “well-considered” interventions, “grounded in both theory and reality”. Although an extensive list of guidelines (see tables 3.2 to 3.9) was developed, broad guidelines with deep theoretical roots that could be practically applied in reality were initially suggested in the first meso-cycle. In tables 4.2 and 4.3, the interventions are summarised for MC1 and MC2. The guidelines are identified with the numbering “A” to “AF”, as assigned in tables 3.2 to 3.8.

For the first intervention in MC1 as indicated in Table 4.2, cooperative learning (CL) and cooperative pair programming (see sections 2.4 and 2.4.1.3) were applied as teaching-learning strategies. Students were randomly, and thus heterogeneously, assigned to groups by the facilitator. Formal and informal groups (see section 2.4.1.2) were formed. Groups had to discuss worked-out examples based on real-life scenarios. Complex tasks had to be completed by groups in class, followed by individual tasks, which students had to complete in their own time out of class. Examples of problems that were not correctly solved were also given to students. In their CL groups, students then had to determine if they agreed with the solutions, thus encouraging constructive controversy.

Not all tasks that students completed in their own time individually had to be submitted on the online learning management system for assessment. Students were also encouraged to complete other exercises indicated in their textbooks, as determined by their learning needs. At the start of the semester, students received a schedule for the semester, indicating the themes of each class, and assignments that had to be submitted. Before each class, students were required to prepare for class by working through a certain section of the textbook, which was also indicated on the schedule. Students could submit assignments at any time before the date specified in the schedule and they could accordingly plan their own schedule around the required activities.

The course content was restructured for a holistic approach (see Table 3.7, guideline X) within the module outcomes, to first give a broad overview of all topics, and thus all objects in a database. The focus then moved to a deeper understanding of a specific topic or object, but still incorporating other objects. For example, although the theme of the lesson was designing tables and focusing on data types and field sizes, students would still be required to do a simple query, form and report on a table that was designed.

Table 4.2: Interventions and guidelines applied in the first meso-cycle (MC1)

INTERVENTION	GUIDELINE	DESCRIPTION OF GUIDELINE
First intervention	A, D, E, H, K, M	CL and cooperative pair programming are applied as teaching strategies, incorporating the five essential elements of CL.
	J	The roles of navigator and driver are swapped at specific time intervals indicated by the facilitator.
	AE	Students are randomly assigned to groups by the facilitator to form heterogeneous formal or informal groups.
	F, G	Encourage students to ask essential questions, and cultivate the habit of asking good questions.
	C	Incorporate complex tasks.
	H, P, Q, R, AA, AB, AC	Provide students with worked-out examples. Focus on real-life scenarios and compare and contrast examples. Include unsolved problems and incorrect solutions to problems to discuss critically and debate in groups to incorporate constructive controversy.
	S	Provide limited feedback and guidance to learning tasks by the facilitator. Structure learning tasks in task classes.
	T	During the group discussion give feedback on overzealous transfer.
	W, D	Aim for mastery-approach goals, such as focusing on developing competence and attaining skills, rather than performance goals, by fostering positive interdependence.
	O, X, Y	Restructure course content for a holistic approach. Restructure course material to revise new material. Provide an overview, and each time revisit topics at a deeper level. Provide repeated experience with the same information but in different contexts.
	Z	Follow a whole-part approach for learning tasks, and order learning tasks in task classes.
Second intervention	All guidelines as indicated above still apply.	
	U, V	Students need to design and do an authentic task as a database project.

In the second intervention of MC1 (see Table 4.2) students were required to design an authentic task and do a database project. They could decide on any scenario that interested them personally, and they had to formulate the problem scenario and design and implement a solution. The project was done individually, as time did not allow for doing the project in class time in cooperative groups. Opportunities were, however, created in class for students to discuss their projects in groups, present their scenarios, critically evaluate each other's designs, and discuss difficulties and challenges that they experienced.

In MC2 (see Table 4.3), CL and cooperative pair programming and all guidelines as indicated for MC1 were applied. More focus was, however, placed on guiding students through inquiry activities first and doing some problem-solving, instead of following a tell-first approach. A greater variety of complex problems based on real-life examples was given to groups, to assist them in recognising deep-structure similarities in problem scenarios, with the aim of far transfer.

Table 4.3: Interventions and guidelines applied in the second meso-cycle (MC2)

INTERVENTION	GUIDELINE	DESCRIPTION OF GUIDELINE
First intervention First intervention		All guidelines as indicated in MC1 were applied in MC2.
	AD	Focus on guiding students through inquiry activities first and do some problem-solving, instead of following a tell-first approach.
	C, G, H, N, Z, AA	Give a variety of real-life, complex problems on various scenarios, to assist learners in recognising deep-structure similarities in problem scenarios, to develop far transfer. Provide more worked-out examples, progressing in complexity. Combine groups to compare and debate their solutions to complex problems, to cultivate the habit of asking good questions, and to foster critical thinking. Focus more on comparing and contrasting examples, to identify deep-structure similarities.
	I	Administer knowledge surveys to students.
	L	Include metacognitive questioning.
	B	Match the level of SDL required to students' level of readiness, and make progression towards student-directed learning over a period of time.
	AF	Introduce collaboration scripts to inexperienced groups initially. Care should be taken not to allow collaboration scripts to distract learners' attention and thus limit deep processing of content. In collaboration scripts, indicate when to swop roles. The driver operates the computer, and the navigator writes answers on scripts.
Second intervention		All guidelines as indicated above still apply. However, at this stage collaboration scripts (guideline AF) are no longer required, as group skills have been acquired.
	U, V	Students need to design and do an authentic task as a database project.

In MC2 more focus was also placed on matching the level of SDL required to students' level of readiness. Students were provided with online links to knowledge surveys (see Appendix L), to assist them in identifying their learning needs and improving metacognition. Collaboration scripts (see Appendix M) were initially issued to groups, to reduce the extraneous cognitive load of deciding on transactive group activities. The scripts also indicated when the roles of navigator and driver had to be swapped, and they included metacognitive questions. In the second intervention of the second meso-cycle, no further guidelines were implemented. At this stage, collaboration scripts were phased out, as students had gained experience of working in their

groups. Students again had to formulate a problem scenario and design and implement a database solution to an authentic problem of their own choice, as in the first meso-cycle.

In this section a motivation for design research as the research methodology has been given. Various models of design research were discussed, and the research design used to develop DSDL was elaborated on. A detailed description of the interventions applied was also given. In the following section, mixed methods research embedded in design research will be discussed.

4.2.3 Mixed methods research

Mixed methods research is a relatively new approach to research, which has in recent years grown in popularity (Bergman, 2008:1; Creswell, 2014:217). In mixed methods research both qualitative and quantitative data are collected and integrated (Creswell, 2015:537). This integrative approach provides a “more complete understanding of a research problem” (Creswell, 2014:4) than using only a qualitative or a quantitative approach. According to Patten and Newhart (2017:165), qualitative data reflects how participants construct reality and their perceptions of situations. Quantitative data, by contrast, is said to give a more objective description of reality (Patten & Newhart, 2017:165). Creswell (2015:537), however, emphasises that mixed methods research is not about only collecting different types of data, but about combining, connecting, building and embedding different data sets.

4.2.3.1 *The purpose of and the motivation for mixed methods research*

Several reasons exist for adopting mixed methods research. Firstly, when doing research from a pragmatic paradigm, qualitative and quantitative research methods are used (see section 4.2.1). Secondly, mixed methods research can provide “a more complex understanding” (Shannon-Baker, 2016:321) of the research problem.

According to Bazeley (2010:451), mixed method researchers are often confronted with small populations. In such studies, through using various methods to collect data, more data can be collected (Creswell, 2015:537). Qualitative results can, for example, expand on or explain the quantitative results based on small sample sizes (Creswell, 2014:225). A third reason for adopting mixed methods research, therefore, is to confirm, explain or expand on results. By using different types of data collection methods, the integrity of the research is strengthened by methods triangulation (Patten & Newhart, 2017:156) (see section 4.5.3). When one type of research is therefore not sufficient to answer the research questions, another type of research is added (Creswell, 2015:537). Thus, different views on what is researched are obtained, providing better insight into the research problem (Greene & Hall, 2010:125-126). Rich data to best answer the research questions can thus be collected (Hesse-Biber, 2010:3) with mixed methods research.

In this study, the research questions required a complex understanding of the real world, and various research methods therefore needed to be used. Another reason for adopting mixed methods research was the relatively small population (see section 4.3). With mixed methods research, more data could thus be collected, and the integrity of the research could be strengthened by methods triangulation. Different views on the results of the interventions, and thus on the research problem, could be obtained. Mixed methods research therefore provided rich data to best answer the different research questions.

4.2.3.2 *Embedded mixed methods design, combining convergent and explanatory sequential approaches*

According to Creswell (2015:541), various models for mixed methods research exist. To determine the model to be used in a study, Creswell (2015:542) proposes that three factors need to be taken into account. The intention for combining various methods should first be considered, that is, whether qualitative and quantitative results need to be compared, or whether a better understanding of the research problem needs to be provided. The second factor is timing, that is, whether data sets will be collected concurrently or sequentially. The third factor is whether one set of data will be more emphasised in the study, or whether both sets of data will be treated equally (Creswell, 2015:542).

In view of these three factors mentioned above, Creswell (2018:113) proposes three core mixed methods designs: the convergent design, the explanatory sequential design and the exploratory sequential design. Creswell (2014:228) also mentions an embedded mixed methods design, that can be nested within a larger design. With an embedded mixed methods design, qualitative data can be collected at several stages, before, during or after an experiment (Cresswell, 2014:228). Elements of convergent, explanatory sequential, and exploratory sequential methods approaches can also be incorporated into an embedded mixed methods design (Creswell, 2014:227). Creswell (2018:169) further proposes several complex mixed methods designs: the experimental design, the case study design, the participatory-social justice design and the evaluation design. Discussing all of the designs is beyond the scope of this study, and only the embedded mixed methods design, convergent design and explanatory sequential mixed methods design (Creswell, 2018:134; Patten & Newhart, 2017:178), applicable to this study, will be discussed. Before discussing the designs, notation used in mixed methods research first needs to be explained.

When reporting on mixed methods research, quantitative methods are indicated by the abbreviation “QUAN”, and qualitative methods are indicated by the abbreviation “QUAL” (Teddle & Tashakkori, 2010:21). The notation “QUAN→QUAL” accordingly refers to two phases: a quantitative research method, followed by a qualitative research method (Teddle &

Tashakkori, 2010:21). The use of upper-case letters indicates higher priority (Creswell, 2015:540). The notation “QUAN→qual” thus indicates that the quantitative data has higher priority or greater weighting than the qualitative data (Creswell, 2015:540).

The convergent mixed methods design is also referred to as the “convergent parallel mixed methods design” (Cresswell, 2014:219). The idea is that quantitative and qualitative data are collected “using the *same or parallel variables, constructs or concepts*” (Creswell, 2014:222). Several reasons exist for using a convergent mixed methods design (Creswell, 2018:123). One intend is to provide the best understanding of the research problem (Creswell, 2018:123), by comparing quantitative and qualitative results. The convergent mixed methods design can thus be used to support quantitative findings with qualitative findings (or vice versa) (Creswell, 2018:123). Results of open-ended questions on a questionnaire can for example “confirm or validate” results of closed-ended questions (Creswell, 2018:131). Another variant suggested by Creswell (2018:129) is where two parallel data sets are collected and then analysed separately. The two data sets are then only integrated when discussing the results. One suggestion to integrate the data sets is to convert qualitative data into counts and then merging the transformed qualitative data with quantitative data (Creswell, 2018:126). The convergent design can also be applied to examine relationships among variables (Creswell, 2018:123). When describing a convergent mixed methods design, the data collection phases will typically be indicated as QUAN + QUAL, meaning that the quantitative and qualitative data collection methods occur concurrently (Creswell, 2018:116).

The primary intent of the explanatory sequential design is to use qualitative results to explain initial quantitative results (Creswell, 2018:134). According to Creswell (2015:545), quantitative data “provide a general picture of the research problem”, and consecutive collection and analysis of qualitative data is often needed to explain the results of the quantitative data. Another possibility is that results obtained from quantitative data in the first phase can be used to plan the second, qualitative phase (Creswell, 2018:134). Participants can, for example, be selected for qualitative data collection, based on the results of initial quantitative data collection (Creswell, 2018:134). The explanatory sequential mixed methods design is depicted in Figure 4.6. The term “sequential” indicates that quantitative and qualitative data are collected consecutively, in two phases (Creswell, 2018:138). The term “explanatory” indicates that the results of data collection in one phase will be explained by the results of data collection in the other phase (Creswell, 2015:545). The phases can for example be indicated as “QUAN→QUAL” (Creswell, 2015:545), or “quan→QUAL” (Creswell, 2014:229), where quantitative data is collected and analysed first followed by collection and analysis of qualitative data.

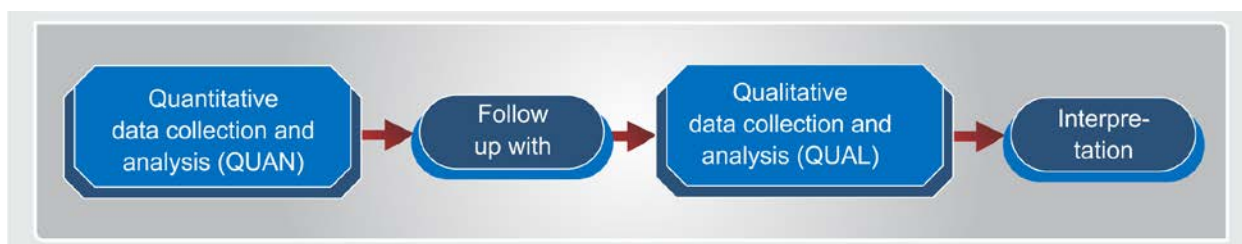


Figure 4.6: Explanatory sequential mixed methods design (Creswell, 2014:220)

In this section, mixed methods research was explained, and reasons were given for using mixed methods research in this study. In the following section, the mixed methods design applied in this study to determine how to develop DSDL will be discussed.

4.2.3.3 Mixed methods research applied for developing deeper self-directed learning

Research aim 4 of this study consisted of four research sub-aims, which required a combination of research methods to collect data (see Table 4.4). By using quantitative and qualitative research methods, various perspectives were gained on participants' inclination to transfer, the factors that prevented transfer, participants' perceived level of SDL readiness, and their experiences of the interventions. In Table 4.4 the research sub-aims (4a, 4b, 4c, and 4d), with the applicable research methods and instruments that were used in this research, are summarised. Quantitative methods were employed to determine participants' perceived self-directed learning abilities, their inclination to transfer and their application of transfer. Qualitative methods were employed to provide explanations of the effectiveness of the interventions and to determine participants' inclination to transfer and the factors that hindered or promoted transfer, so as to further explain participants' perceived self-directed learning abilities and their inclination to transfer. The instruments and data collection methods will be elaborated on in section 4.4.

Table 4.4: Research sub-aims and methods

	RESEARCH SUB-AIM	METHOD	INSTRUMENTS AND DATA COLLECTION METHODS
4a	To determine students' experiences of implementation of the suggested guidelines	QUAL	Interviews
4b	To determine the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills	QUAN + QUAL	Transferable Learning Orientations (TLO) tool
		QUAN → QUAL	Transfer test followed by interviews
4c	To determine the factors that hindered or promoted transfer	QUAL	Interviews
4d	To determine the effect of deliberate implementation of the suggested guidelines on students' SDL	QUAN	Self-Rating Scale of Self-Directed Learning (SRSSDL)
		QUAL	Interviews

A convergent mixed method approach was applied as part of the embedded mixed methods design. Qualitative data in the form of open-ended questions were collected with the TLO questionnaire (see section 4.4.1.2.2) at the start and at the end of each meso-cycle. During the interviews, open-ended questions were asked to collect data on similar concepts as in the questionnaires (Creswell, 2014:222), namely SDL and transfer. Qualitative data and quantitative data were however analysed separately to eventually compare the results of both data sets (Creswell, 2014:219).

The design also had an explanatory sequential approach, as the results of the transfer test (QUAN) (see section 4.4.1.1) determined the participants that were invited (QUAL) for interviews (see section 4.4.2.1). Qualitative methods (interviews) also had to explain the conceptualisations in the transfer test. The results of the quantitative data analysis also had to be explained by qualitative data, because of small sample sizes (Creswell, 2014:225). Equal weightings were in assigned to the quantitative and the qualitative data. The design is sequential because the quantitative data were first collected after each intervention, followed by qualitative data collection (see Figure 4.7).

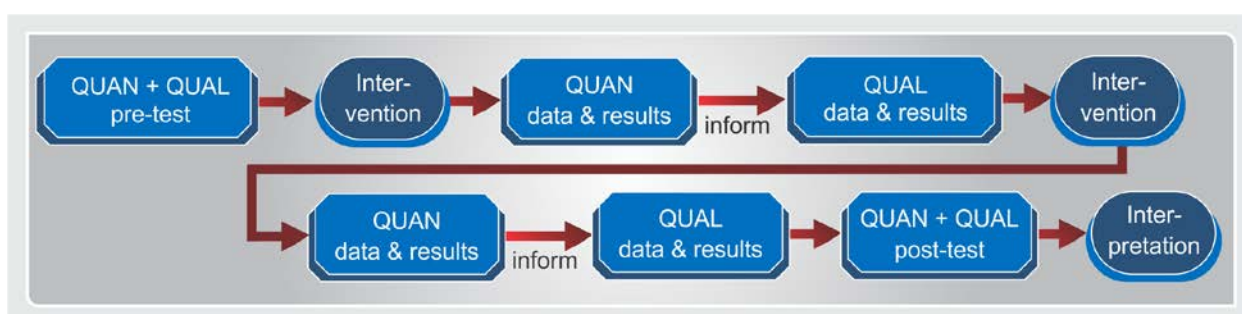


Figure 4.7: Phases of the mixed methods research design in a meso-cycle
(Source: own contribution)

In this study an embedded mixed methods design was nested in design research. Figure 4.7 indicates the various phases of data collection, the sequence of data collection, and when results of qualitative data was informed by results of quantitative data. After each intervention, qualitative data were collected to determine participants' experiences of the interventions. Combined convergent and explanatory sequential mixed methods approaches were incorporated within the embedded mixed methods design.

In the following section a discussion will be given of the participants, the population and the sampling procedure of this study. Thereafter the various quantitative and qualitative data collection methods used in the various phases of the mixed methods research will be discussed.

4.3 PARTICIPANTS, POPULATION, AND SAMPLING

In this section, the participants, the population, and the sampling procedure as applied in this study are discussed. Although mention will be made of the data collection methods employed, namely questionnaires and semi-structured interviews, in order to explain the sampling procedure, these data collection methods will only be discussed in section 4.4.

As indicated in Table 4.1, the empirical study was done in the second and the third years of the study. According to Mertler (2016:263), a population is “all the individuals who make up a designated group” that is going to be studied. The population of participants (N = 73) was two consecutive years of third-year CAT education students at a South African university enrolled for a database and networking module. The module was presented in the second semester of a year. The population therefore consisted of two different groups of students that were enrolled for the module. Thirty-two students were enrolled for the module in the first year, and 41 students were enrolled for the module in the following year.

Due to various reasons, it is seldom possible to study the whole population. Only participants that give informed consent to participate in a study can be studied. In addition, according to Bartsch (2013:31), researchers who study teaching and learning are often limited to which students they can study, and obtaining a sample that will generalise to all students can rarely be accomplished. Due to the various factors that could possibly hinder transfer, and considering the small size of the population, a sample from the population would not have been sufficient to reflect the characteristics of the population closely (Mertler, 2016:263). Therefore, non-probability sampling and a convenience sampling approach (Creswell, 2015:145) was used. The sample consisted of all students who were willing to become involved in the research and who gave informed consent. These students will in the remainder of the study be referred to as participants. Accordingly, questionnaires were administered to all willing participants, and all willing participants were invited to interviews.

4.4 DATA COLLECTION AND ANALYSIS

In view of the pragmatic paradigm adopted in this study (see section 4.2.1), various data collection methods were employed to obtain the best solution to the research problem. In the following section, the quantitative data collection methods used in this study will be explained, followed by the qualitative data collection methods.

4.4.1 Quantitative data collection methods and analysis

When doing quantitative studies, researchers have to identify the variables applicable to the study (Patten & Newhart, 2017:81). The term “variables” refers to characteristics of participants that can vary in the population and which can be measured (Creswell, 2014:52; Patten & Newhart, 2017:74). Independent variables are those that affect the outcome of the research

(Creswell, 2014:52), for example the intervention that was applied. Dependent variables can be defined as the results (Creswell, 2014:52), for example participants' level of SDL and their inclination to transfer.

According to Mertler (2016:109), quantitative data collection is specific and narrow and focuses on measurable variables, to provide a "snapshot of the topic" (Mertler, 2016:89) being studied. The strength of quantitative data, however, is to provide a general picture of the research problem, or to record outcomes of experiments Creswell (2015:545, 549).

One of the purposes of quantitative data collection is to describe current situations in an objective way (Mertler, 2016:109). The purpose of quantitative data collection methods in this study, therefore, was to use reliable instruments to measure participants' perceived SDL and their inclination to transfer in an objective manner. Transfer tests, the Self-Rating Scale of Self-Directed Learning (SRSSDL), and the Transferable Learning Orientations (TLO) tool questionnaires were thus used as quantitative data collection instruments. These instruments and the analysis thereof will be discussed next.

4.4.1.1 *Transfer tests*

In order to determine how participants transferred their knowledge, and to answer research question 4b (see Table 4.4), a transfer test (see Appendix J) was administered after each intervention, as indicated in Figure 4.5. The transfer test can be described as a questionnaire consisting of open-ended questions. The questions are open-ended in that participants had to answer the questions in their own words (Johnson & Turner, 2003:303). A mark was allocated to each answer, to quantitatively determine the transfer attempt, as suggested by Lobato (2003:18).

Although transfer tests are described as quantitative data collection instruments, they also had the purpose of being used as personal documents. Documents in which the characteristics of participants find expression, so that the reader of the document can learn more about the views of participants, are described as personal documents (Babbie & Mouton, 2001:300). According to Babbie and Mouton (2001:300), personal documents allow the researcher to probe into the heart of participants' understanding of the content. Personal documents can thus serve as objective instruments that balance subjectivity when having to make interpretations (Babbie & Mouton, 2001:300).

From studying the transfer tests, a better and an objective perspective could thus be obtained of participants' understanding of the content, in searching for factors that hindered transfer. The transfer tests were also studied to identify the questions or topics that participants had the most

difficulty answering, thus hindering transfer. According to De Vos *et al.* (2011:381), this type of analysis that aims to determine quantities is associated with quantitative data analysis.

4.4.1.2 Questionnaires

Creswell (2008:55) describes questionnaires as data collection instruments designed for measuring specific variables in research. Specific questions are developed in order to obtain quantifiable data from participants. Demographic characteristics of participants can also be recorded with questionnaires. These data can provide a better understanding of participants (Bartsch, 2013:31), and the relevance of their demographic characteristics to other findings may later be found (Bazeley, 2010:441).

In this study, two questionnaires were used. The Self-Rating Scale of Self-Directed Learning (SRSSDL) (Williamson, 2007) was used to determine participants' perceived level of SDL. Answers to research question 4d could thus be obtained, to determine the effect of implementation of guidelines on participants' SDL (see Table 4.4). The Transferable Learning Orientations (TLO) tool (Simper *et al.*, 2016) was used to determine participants' inclination to transfer. Answers to research question 4b could thus be obtained, to determine the effect of implementation of guidelines on transfer of knowledge (see Table 4.4).

The SRSSDL and the TLO were both administered to participants as a pre-test and a post-test at the beginning and at the end, respectively, of each meso-cycle (see Figure 4.5). Generally, student attendance in the first week and the last week of classes is poor. The second week and the second-last week of the semester in which the module was presented were therefore identified as the most suitable times to complete the pre-test and the post-test, respectively. A link to the SRSSDL and the TLO, which were made available on Google Forms, was provided to participants who had given informed consent. Willing participants then completed the questionnaires online.

In the sections below, the SRSSDL and the TLO will be elaborated on.

4.4.1.2.1 The Self-Rating Scale of Self-Directed Learning (SRSSDL)

According to Williamson (2007:26), the SRSSDL is "a valid and reliable instrument" to determine students' SDL levels in learning. The SRSSDL has often been used in the South African context, and the validity of the SRSSDL has also been confirmed for the South African context (Breed & Bailey, 2018:5). The SRSSDL consists of 60 questions, which add up to a total score of 300 (Williamson, 2007:78). Each question is scored on a Likert scale of 1 to 5, where the response key is 1 = Never, 2 = Seldom, 3 = Sometimes, 4 = Often, and 5 = Always. Five broad categories, or variables, are identified in the SRSSDL, as named in Table 4.5. Each category consists of 12 questions. The relevant question numbers for each category are also indicated in

Table 4.5. Demographic characteristics of participants, such as age group, gender, and course enrolled for, are also recorded.

Table 4.5: Categories of the SRSSDL

CATEGORY	QUESTIONS
Awareness	Q8 to Q19
Learning strategies	Q20 to Q31
Learning activities	Q32 to Q43
Evaluation	Q44 to Q55
Interpersonal skills	Q56 to Q67

4.4.1.2.2 The Transferable Learning Orientations (TLO) tool

The TLO was developed to determine students' inclination towards lifelong learning (Simper *et al.*, 2016:1159, 1173). Simper *et al.* (2016:1162) identified transfer as a dimension of lifelong learning, along with motivation, learning belief, self-efficacy, and organisation (see table 4.6). The TLO measures each of these dimensions of lifelong learning, which will be referred to as categories in the rest of this discussion. The TLO can be described as a triangulated measure, consisting of four scale items for each of the categories mentioned above, as well as one rubric-type question and one open-ended question per category (Simper *et al.*, 2016:1165).

Feedback on scale items is based on a five-point scale, with responses ranging from "Not at all like me" to "Very true of me" (Simper *et al.*, 2016:1162). A rubric-type question is also included for each category, consisting of four benchmarked answers at increasing levels of complexity (Simper *et al.*, 2016:1166). The rubric-type questions are thus given on a four-point Likert scale (Simper *et al.*, 2016:1168).

Adding open-ended questions to questionnaires, which, in effect, are quantitative data collection instruments, has become common practice (Bryman, 2006:103). Closed-ended questions are followed by open-ended questions, to allow respondents to provide comments that will explain their responses (Bazeley, 2010:439). According to Simper *et al.* (2016:1165), the aims of the open-ended questions in the TLO are to increase the validity and reliability, to provide more in-depth feedback about why a student reports at a particular level, and to increase students' "meta-cognitive engagement with the instrument" (Simper *et al.*, 2016:1165). The open-ended questions were analysed as qualitative data. This will be discussed in section 4.4.2.2.

For each participant, individual results for each category of the TLO can be plotted on a spider diagram (Simper *et al.*, 2016:1169), to provide a visual representation of the average scores for each category. One aim of the spider diagrams initially was to provide a basis for lecturers to address the needs of their students (Simper *et al.*, 2016:1161). Simper *et al.* (2016:1172)

suggest that the TLO can also be administered before and after a specific pedagogical intervention, to determine its impact, for instance the suggested guidelines to develop DSDL. In the original research of Simper *et al.* (2016:1169) the spider diagrams were also given to students to provide them with immediate feedback after they had completed the questionnaire. Other descriptions were then provided to the categories, in order to present the results in “plain language” to students (Simper *et al.*, 2016:1169).

These descriptions in plain language were accordingly used when annotating the spider diagrams in this research. Instead of the term “outcome motivation”, the description “self-motivated” was used; instead of “learning belief”, the description “flexible learner” was used; instead of “transfer”, the description “makes connections” was used; instead of “organisation”, the description “learns independently” was used. Table 4.6 shows the categories measured by the TLO, as well as the descriptions used for the various categories in the spider diagrams. Table 4.6 further indicates which questions on the questionnaire relate to which category. Questions that are reverse-coded are indicated with (r).

Table 4.6: Categories measured by the TLO

CATEGORY	DESCRIPTION ON SPIDER DIAGRAM	EXPANDED DESCRIPTION OF EACH CATEGORY (Simper <i>et al.</i> , 2016:1166)	QUESTIONS	OPEN-ENDED QUESTION
Outcome motivation	Self-motivated	Intrinsic motivation	Q1, Q2(r), Q3(r), Q5	Q4
Learning belief	Flexible learner	Level of control that participants believe they have of their own learning	Q6, Q7, Q8(r), Q9(r), Q11	Q10
Self-efficacy	Confident	Confidence in learning and performance	Q12(r), Q13, Q14, Q15, Q17	Q16
Transfer	Makes connections	Inclination of participant to transfer knowledge	Q18, Q19, Q20, Q22	Q21
Organisation	Learns independently	Inclination of participant to learn independently	Q23, Q24, Q25(r), Q26, Q28	Q27

4.4.1.3 Analysing the quantitative data

The quantitative data were analysed by statistical consultation services, using the software Statistical Package for the Social Sciences (SPSS) and Microsoft Excel, by applying descriptive and inferential statistics. Descriptive statistics attempt to describe the data for better

understanding, while inferential statistics aim to generalise the results obtained by a sample of the data to the population (Patten & Newhart, 2017:203-204). Examples of descriptive statistics used in this research are frequency distributions, mean values, and standard deviations. They will be explained in the two paragraphs below.

Frequency distributions indicate the number of times a specific value of a variable occurs (Mertler, 2016:270), for example the number of participants that improved their transfer scores from the pre-test to the post-test. The mean value of a variable is determined by calculating the average of all scores on that variable (Mertler, 2016:271). As each category of the SRSSDL and the TLO consists of several questions, the average score of the relevant questions indicates the mean value of a category.

The standard deviation can be defined as the “average distance of the scores from the mean” (Mertler, 2016:275), and it indicates the variability among scores (Mertler, 2016:276). A small variability is indicated by a small standard deviation (Patten & Newhart, 2017:219), and it indicates that the mean scores of participants for that variable are in a close range. Mertler (2016:276) advises that both the mean and the standard deviation should be reported. This will provide ample information about the scores (Mertler, 2016:276), to indicate the average score as well as the fluctuation between the average scores of individual participants.

Inferential statistics calculated in this research were *t*-tests, correlation coefficients, probability values, or *p*-values, and effect sizes. *T*-tests were used to indicate the difference between the means of the pre-test and the post-test. The probability values, or *p*-values, of results were calculated to determine if results are statistically significant. If a finding is indicated as significant, it can be said that the finding is probably relevant for the population of the current research as well (Mertler, 2016:263). Conversely, if a finding is indicated as non-significant, it implies that the finding is not relevant for the population (Mertler, 2016:263). Bazeley (2010:439) states that researchers need to be conscious of sample sizes, as significance of differences can easily be misinterpreted when dealing with small samples. It is further recommended that researchers first determine whether the difference is statistically significant before they report on the effect size (Patten & Newhart, 2017:265). Because a random sample from the population was not drawn in this study (see section 4.3), the *p*-values were not relevant and were reported for completeness sake. However, emphasis had been placed on the interpretation of effect sizes.

Effect sizes indicate the “magnitude of a difference” (Patten & Newhart, 2017:261), and they are expressed as a standardised metric, regardless of the scale of the raw score that was used (Patten & Newhart, 2017:267). Two measures of effect sizes that are widely used are Cohen’s *d* and the Pearson correlation coefficient (Pearson’s *r*) (Patten & Newhart, 2017:267). The cut-off

points for Cohen's *d* effect sizes are 0.20 (for a small effect), 0.50 (for a medium effect) and 0.80 (for a large effect) (Ellis, 2010:41). According to Higgins *et al.* (2013), smaller effect sizes than those indicated by Cohen may also be important, and smaller cut-off points have been proposed for Cohen's *d*. In this study, the cut-off points as suggested by Cohen will, however, be applied.

To determine relationships between categories in the TLO and the SRSSDL, statistical correlations between the two instruments were done (Mertler, 2016:262). Correlation coefficients indicate measures of direction and the degree, or strength, of relationships between variables, which can range from -1.00 to +1.00 (Mertler, 2016:276). The sign of the correlation coefficient only indicates whether it is a negative or a positive correlation, and therefore only the magnitude of the variable is considered when determining the strength of the correlation (Mertler, 2016:276). In general, a correlation coefficient larger than 0.70 indicates a strong correlation, a value between 0.3 and 0.7 indicates a moderate correlation, and values between 0 and 0.30 indicate a weak correlation (Mertler, 2016:277). These values are, however, only general guidelines, and Mertler (2016:276) suggests that correlation coefficients should always be interpreted within the context of the research. It should also be noted that correlation does not imply causation, and interpreting correlations should therefore be done with caution (Mertler, 2016:277).

4.4.2 Qualitative data collection and analysis

With regard to qualitative research, phenomena first need to be described before they can be theorised, and understood before they can be explained (Brinkmann & Kvale, 2015:12). The purpose of including qualitative data collection methods, therefore, was to provide rich, detailed descriptions (Mertler, 2016:89) of the implications of implementing the suggested guidelines to develop DSDL.

In view of the research aims, several reasons for collecting qualitative data existed. Students' experiences of implementation of the suggested guidelines had to be determined (research aim 4a). The factors that hindered or promoted transfer had to be established (research aim 4c). Qualitative data furthermore had to provide more insight on the results of the quantitative data (see Table 4.4), namely the statistical results regarding applying transfer and participants' SDL.

Interviews were mainly used as the qualitative data collection method. As indicated in section 4.4.1.2, the TLO questionnaire also included open-ended questions, which were analysed qualitatively. These data collection methods will therefore be discussed.

4.4.2.1 Interviews

Interviews are a way of finding out how participants understand and experience the world (Brinkmann & Kvale, 2015:xvii). Several forms of interviews exist that can be employed for various purposes. The research interview is described as a structured “professional conversation” (Brinkmann & Kvale, 2015:xvii), with the purpose of constructing knowledge between the interviewee and the interviewer (Brinkmann & Kvale, 2015:xvii).

Two types of interviews were used in this study, namely semi-structured anchored one-on-one interviews and focus group interviews. All the interviews were conducted in face-to-face mode, so as to obtain rich responses (Patten & Newhart, 2017:187). The aims of the interviews were to determine participants’ experiences of the implemented guidelines (research question 4a), to determine the effect of implementation of guidelines on transfer of knowledge and skills (research question 4b), to determine the factors that hindered or promoted transfer (research question 4c), and to determine the effect of implementation of guidelines on students’ SDL (research question 4d).

Semi-structured interviews are recommended by Brinkmann and Kvale (2015:3) when the aim is to understand how participants experience a phenomenon, in the case of this research the intervention applied to develop DSDL. Semi-structured interviews should not be seen as open conversations (Brinkmann & Kvale, 2015:27). They are structured in the sense that questions relating to the research question are carefully planned and decided on beforehand, but still allowing the interviewer to probe the interviewee to clarify remarks and to provide more detailed information (Johnson & Turner, 2003:305). Questions were open-ended in order for participants to voice their experiences unconstrained by the perspective of the interviewer or the findings of past research (Creswell, 2008:225).

When conducting semi-structured interviews, the interviewer guides the theme of the discussion by establishing rapport, and then ask the participant a series of planned questions (Johnson & Turner, 2003:305). Interview protocols have to be set up in advance to guide the interviews, by indicating specific questions targeted at the aims of the research (Patten & Newhart, 2017:187).

In this research, the semi-structured interviews were conducted according to the above guidelines. The purpose of the interviews was indicated to the interviewees, and interview protocols (see Appendix C) to guide the interviews were kept on hand. The flow of conversation of each interview, however, differed, as it was determined by the answers given by the participants (Patten & Newhart, 2017:162). Room was left for follow-up questions not specifically indicated in the interview protocols (Patten & Newhart, 2017:187). The same interview protocols were used for both cycles of the research design, but different interview protocols were developed for the one-on-one interviews and the focus group interviews. In the

following section it will first be explained how participants were recruited for interviews, and then the two types of interviews that were used will be discussed.

4.4.2.1.1 Recruiting participants for interviews

When selecting participants for interviews, it is typical in qualitative studies to select only a few participants, due to the time-consuming nature of collecting and analysing the data (Creswell, 2008:217). In this study, however, all the participants were invited for interviews. The reason for doing so was to obtain multiple perspectives and to aim for data saturation. Because of the relatively small population (see section 4.3), the possibility that all participants invited for interviews would not accept the invitation was also taken into account.

Participants were assigned to specific groups, based on the quantitative results of the transfer tests (see section 4.4.1.1), to determine a basis on which to invite participants to interviews. The groups were called “successful transfer”, “attempted transfer”, and “no transfer”. Participants that obtained between 75% and 100% for the transfer test were assigned to the successful transfer group. Participants that obtained between 50% and 74% for the transfer test were assigned to the attempted transfer group. Participants that obtained between 0% and 49% were assigned to the no transfer group. It was assumed that participants who had passed the transfer test with distinction (between 75% to 100%) could be classified as applying successful transfer. It was further assumed that participants who obtained 49% or less could be classified as not applying transfer. The remainder of the participants, who obtained between 50% and 74%, were classified as attempting transfer.

All the participants from the successful transfer group were invited to a focus group interview (see section 4.4.2.1.3). The number of participants that qualified each time ranged between five and ten participants, which is an ideal size for focus group interviews, as suggested by Krueger and Casey (2009:6). All the participants from the attempted transfer and the no transfer groups were invited to one-on-one interviews (see section 4.4.2.1.2), to determine which factors had prevented transfer (Lobato, 2003:18). It was not disclosed to the participants which group they had been assigned to.

4.4.2.1.2 One-on-one interviews

In one-on-one interviews, only one participant is interviewed at a time (Creswell, 2008:226). Merriam and Tisdell (2016:11) advise that “anchored interviews” be used when observations have been made beforehand that can assist with understanding the context. During the interview, the interviewee can then be asked to explain a certain observation that was made beforehand by the interviewer (Merriam & Tisdell, 2016:11). Although a series of planned questions was asked during the interviews, questions were also asked about observations made when studying interviewees’ transfer tests. A participant could thus be asked to explain

what their understanding of the content and their thinking was when solving a specific problem or answering a certain question in the transfer test. The interviews were thus anchored by observations made from the transfer tests, and they can therefore be described as anchored one-on-one interviews.

Although Creswell (2008:226) suggests that one-on-one interviews are ideal for participants who are “not hesitant to speak”, an element of embarrassment might exist for participants who did not perform well in the transfer tests. Therefore, one-on-one interviews were decided on to allow participants to freely and privately discuss their experiences and their misconceptions, without feeling embarrassed in front of the other participants. Initially, 30 minutes were allocated for each one-on-one interview, but the interviews often took longer.

4.4.2.1.3 Focus group interviews

Focus group interviews are conducted with participants that share a common characteristic, and they have the purpose of gathering opinions, determining perceptions, and obtaining a clearer understanding of participants' experiences of an issue (Krueger & Casey, 2009:2). In this study, participants had the common characteristic that all had obtained 75% or more for their transfer tests. It was assumed that because all the participants in this group had performed well in their transfer tests, they would be open to share their good practices, experiences, and strategies in a group (Krueger & Casey, 2009:2; Patten & Newhart, 2017:164). It was therefore assumed that the best information could be obtained from the successful transfer group by means of a focus group interview, as suggested by Creswell (2008:226).

According to Krueger and Casey (2009:4), focus group interviews work best if participants feel they are being respected, they feel comfortable, and they feel that they can freely express their opinions and views. Key roles of the interviewer are to be prepared how to handle individuals that may dominate the discussion, to be focused on the research aims, and not to let the group discussion become sidetracked, by giving information not important to the researcher (Krueger & Casey, 2009:7, 15). It was therefore important to set a welcoming tone in the focus group interview, by congratulating participants on their performance and inviting them to share their experiences of the intervention and the teaching-learning strategies. Furthermore, questions asked in the focus group interview had to be planned carefully. Open-ended questions were asked, focusing on the research aims and allowing all participants to contribute by voicing their opinions. The interviewer had to be attentive to certain issues, for example allowing all participants to voice their opinions and to stay focused on the planned questions indicated in the interview protocol. The focus group interviews lasted approximately an hour.

4.4.2.2 *Analysing the qualitative data*

The process of analysing qualitative data can be described as a non-linear, iterative process that entails reading through transcriptions, assigning codes to quotes from the text, and finding emerging themes (Creswell, 2015:237). Analysing qualitative data further requires understanding of how to make sense of transcriptions and answers to open-ended questions, in order to formulate answers to research questions (Creswell, 2015:235).

After collecting the qualitative data, it had to be prepared for analysis. Recorded interviews were transcribed and checked by reading the transcriptions while listening to the interviews again. Transcriptions of interviews and answers to open-ended questions in the TLO were analysed by importing them into ATLAS.ti software. This software belongs to the family of QDA (qualitative data analysis) software, which was specifically developed to facilitate analysis of qualitative data (Creswell, 2015:240; Frieze, 2012:1). It is generally accepted that QDA software allows more ease and flexibility when coding transcriptions, and it provides almost endless possibilities for sorting, filtering and comparing codes and themes (Bazeley, 2010:435). A further advantage of QDA software is that researchers can keep audit trails and detailed documentation of codes and changes made (Bazeley, 2010:437), to support verification of codes and themes by other researchers. Using ATLAS.ti, quotes from transcriptions can be assigned codes (Krueger & Casey, 2009:123) by labelling the quotes (Creswell, 2015:242). Ultimately, themes will emerge from the codes, and codes can be collapsed into broad themes. A theme can accordingly be described as an idea that occurs repeatedly (Gibbs, 2007:152).

An inductive or deductive approach can be followed when coding (Creswell, 2015:236; Frieze, 2012:93). When using an inductive approach, codes are assigned to transcriptions while they are read. The order of the coding process will thus entail moving from transcriptions to codes, and then to themes (Creswell, 2015:236). According to Bazeley (2010:440), coding can either be done “on an emergent basis” or be directed (Bazeley, 2010:440). When coding on an emergent basis, codes are assigned as they emerge from the transcriptions, and it is therefore similar to an inductive approach. When following a deductive coding approach, coding can be directed by concepts previously obtained from the literature or prior surveys, and quotes applicable to these concepts are sought during the coding process (Bazeley, 2010:440).

Krueger and Casey (2009:115) point out that people have a tendency to selectively choose comments that confirm their specific point of view. This statement is confirmed by Creswell (2015:237), who states that each researcher brings their own perspective to interpreting the data, and interpretations may therefore differ. It is therefore suggested that researchers continually need to be attentive, to avoid “the trap of selective perception” (Krueger & Casey, 2009:115).

In this study, an inductive and deductive coding approach was followed. Quotes were labelled as codes on an emerging basis, creating codes on participants experiences of the implemented guidelines, transfer, the factors that hindered transfer, and codes on SDL as they emerged. The deductive coding approach was directed by the categories of the TLO and the SRSSDL, and quotes applicable to those categories were sought during the coding process (Bazeley, 2010:440). Throughout the coding process, the purpose of the study and the research aims had to be kept in mind, as the amount of data in transcriptions could lead to distraction, as warned by Krueger and Casey (2009:114). A systematic, transparent and open process was followed when analysing the data, allowing for other researchers to verify the findings if required (Krueger & Casey, 2009:115). Because ATLAS.ti was used for the coding process, the coding and assignment of themes was well documented and transparent for verification by other researchers.

According to Bazeley (2010:443) and Creswell (2018:126), qualitative data can also be analysed by obtaining counts of themes. Counts are viewed as the most common form of incorporating numbers in qualitative data, and they also indicate the relative importance of emerging themes (Bazeley, 2010:444). It is, however, cautioned that the context in which the counts were obtained, for example the number of participants that were interviewed in relation to the population, should be taken into account when quantifying qualitative results (Bazeley, 2010:444). Care should also be taken not to revert to shallow interpretations of qualitative data, by viewing only one dimension, by calculating counts and reporting on numbers (Bazeley, 2010:444). In this study, counts were, for example, done to determine how many participants had mentioned in their interviews that they did not enjoy working in groups. Counts could also be done to determine the topic that most participants had difficulty in applying transfer to as reported in the interviews.

4.4.3 Integrating quantitative and qualitative results

Design research has two main goals: to create an intervention to solve a problem in practice, and to produce a theoretical understanding of a phenomenon (McKenney & Reeves, 2012:201). In order to accomplish these two goals, information was gathered in all the stages of the design. Within the design research, embedded mixed methods design research was used, as explained in section 4.2.3.2. Qualitative and quantitative data had to be analysed and integrated to reflect on the interventions and ultimately achieve the goal of the research (Bazeley, 2010:432).

To integrate data analysis and to find the factors that hindered or promoted transfer (research aim 4c), the actor-oriented transfer (AOT) perspective (Lobato, 2012) was applied. To further provide a rationale for how results were integrated, the AOT perspective will first be discussed.

4.4.3.1 *The actor-oriented transfer (AOT) perspective*

According to Lobato (2012:232), transfer of learning that does *not* happen is mostly noticed. Lobato (2012:232) argues that the AOT perspective can be used to detect transfer, even when it seems that transfer was not applied, where wrong answers were given. The AOT perspective distinguishes between an “actor’s” and an “observer’s” point of view (Lobato, 2012:235). When taking an observer’s point of view, the researcher predetermines the strategies that participants need to demonstrate in order to count as transfer (Lobato, 2012:235).

When taking an actor’s point of view, the researcher investigates which previous experiences determined or shaped a participant’s activity when they attempted transfer, even if transfer was not applied according to the predetermined strategies, which means that transfer questions were answered incorrectly (Lobato, 2012:235). With follow-up interviews after attempting transfer questions, participants’ thinking and their understanding of the transfer problem can then be explained. Participants’ “unanticipated interpretations of instructional experiences” (Lobato, 2012:236) can thus be determined and be connected to their understanding of the transfer problems that they had to solve. Specific elements related to understanding a specific concept can also be identified (Lobato, 2012:236). It is also possible that participants applied negative transfer (see section 2.2.3.1.1), by identifying similar surface features and not recognising that deep-structure features differ.

Therefore, when determining transfer from an AOT perspective, an interpretive epistemology is emphasised. It is not merely concluded that transfer has failed; rather, one should determine qualitatively what participants’ conceptualisations and experiences of learning environments are that could have affected their attempted transfer (Lobato, 2012:236, 240).

In this study, analysis of the transfer tests (see section 4.4.1.1) that participants wrote was accordingly done from an observer’s point of view. It had to be determined whether transfer was applied according to predetermined answers of the transfer test. This, however, did not give an indication of why participants could not apply transfer, or the factors that hindered transfer. Thus, an actor’s point of view had to be taken, by conducting interviews (see section 4.4.2.1) with willing participants. In the interviews, participants could explain their thinking and understanding of database concepts when they attempted to answer questions in the transfer tests. They could also describe their experiences of the teaching-learning strategy applied in class. The aim was to identify misconceptions, or specific aspects related to their understanding of database design, or aspects of the teaching-learning strategy that hindered or promoted transfer.

4.4.3.2 Integrating results to provide answers to the research questions

Creswell (2015:537) states that integrating data in an explanatory sequential mixed methods design entails building on the results of and connecting data sets, by explaining quantitative data with qualitative data. When following a convergent approach, the challenge is “how to actually merge or converge the data” (Creswell, 2014:222). Integrating data in mixed methods designs is thus described as a challenging task, which entails more than mere combining of data sets, as quantitative and qualitative methods can be “deeply intertwined” (Kane & Trochim, 2007:177).

In this study, different data sets (see Table 4.4) accordingly had to be combined, using various strategies of data analysis (see section 4.4), as indicated by Bazeley (2010:432). Data collection and analysis was done at specified intervals within each meso-cycle (see figures 4.5 and 4.7). Quantitative results from the TLO and the SRSSDL were analysed and integrated with the results of qualitative data after the post-tests at the end of a meso-cycle (see Figure 4.2), as suggested for a convergent mixed methods design (Creswell, 2018:129). From these results, it could be determined if students’ SDL and their inclination to transfer showed any improvement after the interventions applied in the meso-cycle. According to the results obtained, the results were interpreted, and the intervention in the following meso-cycle was adjusted accordingly.

From the results of the TLO, spider diagrams to display the averages for each category for each individual participant were drawn. The spider diagrams were compared with the analysis of the individual interviews and the open-ended questions in the TLO. The open-ended questions could further provide “illustrative quotes” (Bazeley, 2010:439) for the results displayed in the spider diagrams. Participants’ experiences as results of the interviews could be used as complementary results to explain the results of the TLO and the averages plotted on the spider diagrams. Thus, a rich understanding of participants’ inclination to transfer and the categories measured by the TLO could be obtained by the comparative analyses of the TLO and the interviews.

Within each meso-cycle, two interventions were implemented (see Figure 4.5). After the first intervention, the quantitative results of the transfer tests determined which participants were invited for interviews to collect qualitative data. In this instance, integration of data was thus done as suggested for the explanatory sequential design (Creswell, 2018:134). In the one-on-one interviews, discussions were anchored by answers in the transfer tests, to determine factors that hindered transfer, as suggested by the AOT perspective (see section 4.4.3.1). Interviews were then analysed to determine participants’ experiences of the intervention. The limited time available to analyse the interviews after the first intervention in each meso-cycle (see Figure 4.5) posed a challenge to the depth in which the interviews could be analysed. According to

Bazeley (2010:438), time constraints are often the case when analysing and integrating data in mixed methods research.

The analysis and integration of all the results from the transfer tests and the interviews informed the next intervention in the meso-cycle. After the intervention was applied, a transfer test was written again. The results of the transfer test again determined the interviews that participants were invited to. At that stage, the end of the meso-cycle was reached, and post-tests of the TLO and the SRSSDL were conducted.

Statistical analysis of the results of the pre-tests and the post-tests of the TLO and the SRSSDL was done. The results of the post-TLO were plotted on the spider diagrams drawn from the pre-TLO (see tables 5.12 and 5.29). A visual interpretation was made of each participant's progress on the various categories of the TLO, in terms of whether it was negative or positive. The next step was to understand participants' progress indicated by the results of the TLO and the SRSSDL, by analysing the second set of interviews. Because the number of participants that completed the TLO and the SRSSDL was relatively small, the qualitative results were used to confirm and explain the results of the TLO and the SRSSDL. Apart from looking for factors that hindered transfer when analysing interviews and open-ended questions from the TLO, themes relating to participants' SDL were also kept in mind. After integrating the results and formulating answers to the research questions, the intervention to be applied in the next meso-cycle was adjusted.

After the above process of collecting and analysing data in MC2 was completed, results from data sets in both meso-cycles could be compared and interpreted. Finally, conclusions were made to form answers to the research questions, and the research could be reported on.

4.5 RELIABILITY AND VALIDITY

According to Creswell (2015:158), the terms “reliability” and “validity” are “bound together in complex ways”. The meaning or interpretation of these terms may therefore sometimes overlap and at other times be mutually exclusive (Creswell, 2015:158). Accordingly, the terms “reliability” and “validity” are often used in conjunction with each other (Mertler, 2016:258; Willis *et al.*, 2007:218), as both terms are important with regard to data collection, results, and analysis of data, and with regard to conclusions and inferences made from results (Mertler, 2016:252). Willis *et al.* (2007:218) suggest that when defining reliability and validity, it should be done in relation to qualitative and quantitative data, as these perspectives will differ because of the differences in the underlying paradigms.

In general, validity is concerned with whether the measuring instrument has fulfilled its purpose and whether the instrument has measured what it was intended to measure when the focus of

the research is reflected on (Mertler, 2016:252; Patten & Newhart, 2017:123). In contrast, the key words when discussing reliability seem to be “consistency” and “trustworthiness” (Creswell, 2015:158; Mertler, 2016:252; Patten & Newhart, 2017:137). In the rest of the discussion it will be indicated how reliability and validity in this research were addressed, by discussing reliability separately with regard to quantitative and qualitative data.

4.5.1 Reliability with regard to quantitative data

Hunter and Brewer (2003:581) view repeated use of a measurement as essential for reliability of quantitative data. According to Creswell (2015:158), reliability can be compromised when questions on instruments are unclear and ambiguous.

Reliability can be confirmed by calculating reliability coefficients (Patten & Newhart, 2017:141) when statistically analysing quantitative data. The Cronbach’s alpha (indicated as α) is commonly used to determine the internal consistency of scores within a test itself (Patten & Newhart, 2017:145). Perfect reliability is indicated by a value of 1, and published tests often have reliability coefficients of 0.8 or higher (Patten & Newhart, 2017:142). A reliability of 0.5 can, however, be accepted for group averages of small samples of at least 25 participants (Patten & Newhart, 2017:142).

In section 4.4.1.2.1 it was mentioned that the SRSSDL has often been used in the South African context, and that it has been confirmed as a reliable instrument. Reliability of the TLO was confirmed by Simper *et al.* (2016:1165), but information on reliability in the South African context could not be found at that stage, and it had to be statistically confirmed. Reliability was, however, improved in this study, by re-administering the questionnaires to different year groups of participants in two subsequent years.

According to Creswell (2015:158), reliability can be compromised if procedures when administering tests vary. In this study, care has been taken to follow the same procedures when administering tests. A link to complete the TLO and the SRSSDL online was each time provided to participants, who could either complete the questionnaires in class or at a time convenient to them. Pre-tests each time had to be completed at an early stage, as they had to be completed before the intervention was applied.

Creswell (2015:158) further states that tests can be unreliable when participants are fatigued or nervous. Participants can thus misinterpret questions or guess answers to questions. Timing when administering transfer tests and questionnaires was a real issue in the current research. Classes were scheduled at fixed times twice a week, and choices for when to administer tests and questionnaires were limited. Transfer tests had to be written during class time, as they were

part of the module's assessment plan. Therefore, a time most convenient for writing tests had to be selected from the scheduled class time.

4.5.2 Reliability with regard to qualitative data

Qualitative research methods have the goal of understanding and interpreting according to the view that reality is socially constructed (Willis *et al.*, 2007:218). According to Creswell (2015:158), reliability is concerned with the trustworthiness of observations in qualitative data collection methods. Several suggestions have been made in the literature to improve reliability with regard to qualitative data.

Morse *et al.* (2002:12) suggest that reliability can be improved when the aim of analysing data is to strive for saturation and completeness, by interviewing as many participants as possible. It has already been mentioned that all participants who gave consent were invited to interviews, and all participants who accepted their invitations were interviewed (see section 4.4.2.1). Morse *et al.* (2002:12) further suggest that reliability can be improved by choosing an appropriate sample of participants who best represent the research, seeking negative cases. In this research no selection bias occurred in selecting the sample, as all participants who gave consent had questionnaires administered to them and were invited to interviews (see section 4.4.2.1). Negative cases were also included, by inviting participants who could not apply transfer to interviews (see section 4.4.2.1).

According to Bazeley (2010:461), various opinions exist of how reliability can be defined when coding and analysing qualitative data. It seems that transparency and consistency of coding are two factors that determine reliability when coding (Bazeley, 2010:461). Regarding transparency, the use of ATLAS.ti as the QDA contributed to the reliability of the coding (Bazeley, 2010:462). Audit trails of the coding process were thus available, and the coding process could be verified and tracked by other researchers. As suggested by Merriam and Tisdell (2016:128), the same coding technique was applied throughout, and the researcher strived to be consistent and to apply sound ethical principles.

4.5.3 Improving validity

Validity of data is concerned with the interpretation of data, once data have been analysed and conclusions have been drawn (Mertler, 2016:253). It can accordingly be stated that reliable tests will not necessarily be valid (Mertler, 2016:258). Willis *et al.* (2007:216) mention that internal and external validity should be considered when determining the validity of research. They consider internal validity as a basic minimum requirement to interpret an experiment, or determining whether a study can be replicated (Willis *et al.*, 2007:216). They, however, debate whether the question of whether research can be replicated is applicable to qualitative research (Willis *et al.*, 2007:218). External validity, by contrast, concerns the generalisability of a study,

and it indicates whether the results of a study can be generalised to other populations (Willis *et al.*, 2007:216-217).

In relation to measuring instruments, such as questionnaires, the concept of validity is used to indicate if the instrument fulfils its purpose and measures what it was intended to measure (Patten & Newhart, 2017:123). The validity of the quantitative data collection methods, namely the TLO and the SRSSDL, has already been confirmed by the literature (see section 4.4.1.2). Participants that are required to give answers of their perceived self, as was the case when completing the TLO and the SRSSDL, may, however, be influenced by social desirability. To increase the validity of such measures, it is suggested that questionnaires should be answered anonymously (Patten & Newhart, 2017:153). Because comparisons of various results had to be made in this research, as already explained in section 4.4.3, full anonymity was not possible.

Validity can also be improved when participants are unaware of the specific characteristics that the researcher is looking for when they respond to a questionnaire (Patten & Newhart, 2017:153). Accordingly, participants were not informed about the specific characteristics or categories that the TLO and the SRSSDL aimed to measure. The SRSSDL and TLO questionnaires use objective measures, because participants respond to five-point Likert scales with response options ranging from “Always” to “Never” (the SRSSDL) (Williamson, 2007:71) and “Not at all like me” to “Very true of me” (the TLO) (Simper *et al.*, 2016:1162). Using such objective measures is also indicated as a measure to improve validity (Patten & Newhart, 2017:154). According to Patten and Newhart (2017:154), statements that are reversely scored can reduce response bias. Several questions in the TLO (see Table 4.6) were accordingly reversely scored.

According to Middleton *et al.* (2008:27), the disciplined nature of design research, with its various cycles of design, testing, and theory building, ensures that rigour is built into research, thereby enhancing the validity of the research. With regard to the mixed methods research built into the cycles of design research (see section 4.2.3), Mertler (2016:156) describes validity as ensuring that valid indicators of variables were obtained, and that valid overall research conclusions were made. Several other indications for validity with regard to mixed methods research exist.

Mixed methods research is often associated with triangulation (Bryman, 2006:105), which is described by Willis *et al.* (2007:218) as “a qualitative equivalent of validity and reliability”. Triangulation is a “widely used” term (Hammersley, 2008:23) with various meanings. In this study, the view of triangulation is as described by Bryman (2006:105), namely “seeking corroboration between quantitative and qualitative data”. Triangulation can therefore improve validity by interpreting conclusions from a variety of data sources (Hammersley, 2008:23). In

this research, triangulation was applied by collecting and analysing qualitative and quantitative data separately and comparing results to validate interpretations. It could then be determined whether the results contradicted or supported each other.

Patten and Newhart (2017:156) refer to methods triangulation, when multiple methods are used to understand a phenomenon as best possible (Delpont & Fouché, 2011:442). Quantitative and qualitative methods are thus applied in the same time frames and with equal weightings, to view a phenomenon from different angles (Hammersley, 2008:27). Accordingly, multiple methods, namely questionnaires, transfer tests, and interviews, were used in this research, to determine the implications of implementing the guidelines to develop DSDL and to view the results from various angles. Thus, methods triangulation was applied.

Researcher triangulation can be attempted when more than one researcher participates in analysing the data (Patten & Newhart, 2017:156). In the current research the interviews were transcribed by a third party, and the analysis of the qualitative data was verified by a co-researcher. The quality of the transcriptions was ensured by the researcher listening and relistening to all interviews and comparing them with the transcriptions. The interviews contained many technical references to databases, and all transcriptions were checked to ensure that the correct terminology was used. No assumptions were made about the quality of the transcriptions.

As already indicated above, external validity concerns generalisation of the results (Willis *et al.* 2007:216). It is acknowledged that this research was done with two year groups of students in a specific module. Therefore, the results cannot be generalised to other populations at this stage. Patten and Newhart (2017:189-190), however, suggest that external validity can be improved by excluding selection bias, by doing the intervention in a natural setting and in real classes (Bartsch, 2013:30), and by reducing the effects of pre-test sensitisation. McKenney and Reeves (2012:8) agree that external validity is improved when studies are done in “real world conditions”. The intervention in this study was applied during class time in a natural setting, as suggested by Patten and Newhart (2017:189-190), as part of the day-to-day teaching and learning (see section 4.2.2.4). Although students were initially informed about the research project and the purpose of the research when recruiting participants, they were not reminded of their participation in the research and the purpose of the research project during the day-to-day class activities. Pre-test sensitisation was therefore minimised by not informing participants of the purpose of the pre-tests and not discussing the aims of the research project. Participants were also not informed about the purpose of the transfer tests, as these tests were viewed by participants as part of the assessment requirements of the module. Selection bias was

excluded, as all willing participants that provided consent were included in the data collection methods (see section 4.3).

The use of more than one group could contribute to the external validity, or transferability (Merriam & Tisdell, 2016:126), of the research. No control group could, however, be used in this research, which could raise doubt about the external validity of the research (Patten & Newhart, 2017:187). Ethical considerations, however, did not allow the use of a control group, as participants in a control group would not be exposed to the teaching-learning interventions (Creswell, 2015:555). The small size of the population was also a factor that had to be taken into account, and it was therefore not viable to divide the population into two groups. Validity was, however, improved by repeating all phases in the meso-cycle in the following year on a different group of participants.

In this section, the concepts of reliability and validity were discussed. It was indicated how these concepts were taken into account when designing the current research, to ensure consistency of the data collection methods and trustworthiness of the data analysis and interpretation. According to Merriam and Tisdell (2016:128), the validity and reliability of a study depend largely on the ethics of the researcher. Accordingly, ethical issues and considerations in this study will be discussed in the following section.

4.6 ETHICAL ISSUES

Creswell (2015:555) states that with mixed methods research, ethical considerations need to be taken into account at multiple points during the research process. According to Merriam and Tisdell (2016:132), ethical considerations with regard to a researcher's relationship to participants are "a major source of discussion and debate". They further state that it is ultimately up to the individual researcher to proceed in an ethical manner (Merriam & Tisdell, 2016:130). Especially in this research, where the population consisted of students in a module facilitated by the researcher, the researcher had to adhere strictly to the prescribed code of ethics (Merriam & Tisdell, 2016:132). The researcher had to uphold a professional relationship with the students and not mention the research project or the aims of the research when facilitating the module. All possible steps had to be followed to behave ethically towards the population, to be aware of possible power relations (Creswell, 2015:55), and not to disclose the identities of participants.

Ethical clearance was obtained from the relevant institutional ethics committee (see Appendix A) prior to any data collection. Because this research required that an intervention be applied in an existing module, which thus involved students from the university, permission to conduct the research also had to be obtained from the university's registrar for each year that data were collected. Such permission was granted, but with the prerequisite that the researcher was not

allowed to collect any data, such as marks or contact details of participants, from any of the university's administrative systems.

All students that were registered for the module had to attend the classes and all students were thus subjected to the intervention. The participants were students in the module that took part in the research voluntarily. Care was taken to respect this vulnerable population and to take into account potential power issues between the researcher and the population. An independent person was recruited to explain the research to the population and to recruit participants. The same independent person handed out and collected consent forms (see Appendix B). The purpose of the research and what would be expected of participants was explained in the consent forms (Merriam & Tisdell, 2016:130). The researcher, who also facilitated the module, was not present during the recruitment process.

Careful measures were taken not to disclose which students in class had agreed to participate in the research, and to treat all students in the population (whether participants or not) with the same respect and empathy (Creswell, 2015:555). Therefore, consent forms were handed out to the whole population. Each student received an envelope for placing the completed consent form in, so as not to disclose the information that students had written. The whole population were then requested to hand in their envelopes, also as a measure to not reveal the identities of participants. Participants had the right to withdraw from the research at any time without incurring any consequences, as indicated on the consent forms. However, as this was a compulsory module, they would still be obliged to attend the classes for the module and to complete regular assessments for the module.

Data were collected at different stages of the research, and participants' data had to be matched. This required that participants' identities had to be recorded when they submitted questionnaires and transfer tests (Creswell, 2015:555). According to Bazeley (2010:439), this is increasingly becoming an issue when trying to adhere to the requirements of ethics committees with regard to anonymity. Participants were requested to provide their student numbers as part of completing the questionnaires. This was, however, only for the purpose of linking pre-tests with post-tests and to select participants for interviews according to the results of transfer tests, and to integrate results from the transfer tests and the TLO with analyses of the interviews. Participants furthermore had to be invited to interviews. Therefore, participants were requested to voluntarily provide their email address on the consent forms, to be contacted if required.

Interviews were scheduled by an independent person, using the application Slottr.com. The same independent person that administered and collected the consent forms sent an email to each participant, inviting them to an interview. The email included a link to Slottr.com, which provided participants with possible dates and times for interviews. Participants could schedule

interview times that suited them best, or they could ignore the email if they opted not to take part in the interviews. This procedure minimised the possibility that participants would agree to take part in interviews because of a power relation between lecturer and student. All interviews were conducted at a convenient venue for participants at the university. The venue was chosen to allow participants privacy and a safe place to voice their experiences, and also not to disclose their identity to other students in the population.

According to Brinkmann and Kvale (2015:16), knowledge produced during interviews depends on the social relationship between the interviewer and the interviewee. Researchers are the primary instruments for collecting qualitative data, which is filtered through their theoretical positions and biases (Merriam & Tisdell, 2016:133). A delicate balance was therefore required between the interviewer's need to uncover knowledge regarding transfer and self-directedness and the need to create a safe environment for the participant to freely discuss their experiences of the intervention and the factors that hindered transfer (Brinkmann & Kvale, 2015:16). When conducting interviews, the interviewer had to remain non-judgemental to the responses of the interviewee, so as to obtain non-biased responses, especially with regard to the interviewees' experience of the intervention (Johnson & Turner, 2003:305). Interviews were therefore conducted in a courteous and professional way, as advised by Creswell (2008:220). All possible measures to ensure confidentiality and to not disclose the identities of participants (Creswell, 2008:238) were also taken.

During questioning in interview situations, it is possible that a process of reflection is prompted and that participants see possible solutions to problems and relations that they were not aware of before (Brinkmann & Kvale, 2015:31). Interviews can therefore also have the function of creating a learning experience for participants (Brinkmann & Kvale, 2015:31) while they discuss issues that hindered transfer. The transfer tests were used to anchor the interviews (see section 4.4.2.1.2), and participants thus had the opportunity to reflect on their mistakes and factors that hindered them from applying transfer. It can therefore be stated that participants were encouraged to freely discuss their experiences of the intervention, as a means to reflect on their understanding, which is also to their benefit, and not only for the researcher to construct knowledge of participants' experiences and understandings.

Audio recordings were done with the permission of the participants, by using two electronic devices, to ensure a backup recording in the event of hardware failure. After the recordings were uploaded for storage, they were deleted from the two devices. Recordings and data were stored on Google Drive, so as to have one password-protected central storage place that the researcher could access from various locations. Participants' names were not mentioned during the interviews, and the participants were therefore not identified in the recordings and the

transcriptions. In the event of participants mentioning the names of their group members or other students in class, the names were replaced with symbols. All the results of the questionnaires were also saved on a drive that was password-protected. Backup copies of all data were made on an external hard drive, which was kept in a safe location.

According to Merriam and Tisdell (2016:133), analysing qualitative data also involves ethical issues. Researchers should be aware of excluding data because of personal biases. In section 4.4.2.2 analysis of qualitative data by using the software ATLAS.ti was discussed. The need for transparency in the data analysis was thus confirmed, as well as the need to have an audit trail, to indicate how the coding and assignment of themes was done. The coding was also done with the research aims in mind, and the transcriptions did not include identification of participants. Personal bias was therefore prevented as much as possible.

Transfer tests were regarded as personal documents, and they were therefore handled with full ethical considerations in mind. As the transfer tests were part of the formative assessment of the module, marked tests were returned to the students. Copies of tests had to be made for use during interviews and data analysis, and they were stored in a safe place. Participants' test results were recorded by the researcher on Microsoft Excel, and they were saved as part of the formative assessment marks of the module by the researcher. The university's administrative system was not at any stage required to obtain marks or other information.

At no stage during the dissemination of the research were the identities of participants disclosed. It was also not disclosed to the participants which group they were assigned to after they had completed the transfer tests (see section 4.4.1.1). At all times, anonymity, confidentiality, and safekeeping of data and results enjoyed highest priority.

4.7 CONCLUSION

In this chapter, the research design to develop guidelines to enhance DSDL was discussed, by referring to the research methodology, the participants, the sampling procedure and the data collection instruments, measures to ensure reliability and validity, and ethical issues. It was indicated why and how design research was used as the research methodology to find answers to all the research questions formulated in this research. It was also indicated why mixed methods research was embedded in the design research, and all quantitative and qualitative data collection methods that were thus required were described. Measures that were taken to ensure reliability and validity of the data collection and analysis were also explained. Lastly, it was indicated how ethical recommendations for research were acknowledged.

In the following chapters the results of the research will be reported on, followed by a discussion of the results and final conclusions.

CHAPTER 5:

REPORTING ON THE RESULTS

In the previous chapters deeper self-directed learning (DSDL) was defined, and guidelines to develop DSDL were suggested. Research aims 1, 2 and 3 were addressed in chapters 2 and 3. In chapter 4 the research design and methodology to determine the implications of implementing the guidelines for developing DSDL (research aim 4) were described. In this chapter, the results of the data collection will be reported on. Reporting will be guided by the research aims as well as the various data collection methods applied in each meso-cycle. The aims of the various data collection methods were to determine students' experiences of implementation of the guidelines (research aim 4a), to determine the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills (research aim 4b), to determine the factors that hindered or promoted transfer (research aim 4c), and to determine the effect of deliberate implementation of the suggested guidelines on students' self-directed learning (SDL) (research aim 4d).

Data was collected in two meso-cycles, from two different year groups of participants (see section 4.4). In each meso-cycle, two interventions were applied (see Figure 4.5). The reporting will thus be done for each intervention of each meso-cycle.

5.1 REPORTING OF RESULTS FROM THE FIRST MESO-CYCLE

The order of reporting will be according to the order of data collection as indicated in Figure 4.5. As indicated by Creswell (2014:223) for a convergent mixed methods design, the qualitative and quantitative results will be reported on separately, and integration will be done during the discussion in Chapter 6. The qualitative results that present participants' experiences of the implemented guidelines after each intervention, and the factors that hindered or promoted transfer, will be reported on first. The quantitative results will, however, only be reported on at the end of each meso-cycle.

As indicated for an explanatory sequential approach, the results of the transfer tests (see section 4.4.1.1) will each time be discussed before the results of the interviews are discussed. These tests determined the selection of participants for the interviews, and they were used as anchored documents in the one-on-one interviews (see section 4.4.2.1.2). Lastly, the effect of applying the guidelines on transfer of knowledge and skills and on participants' SDL, according to the results of the pre-SRSSL and the post-SRSSL and the pre-TLO and the post-TLO, will be reported on. Most of the interviews were conducted in Afrikaans and most of the quotes that are mentioned in this thesis were translated from Afrikaans to English.

During the discussion, themes that emerged from the data will be represented visually by network views created using the QDA software ATLAS.ti (see section 4.4.2.2). Groups and themes indicated in the network views will be referred to as nodes in the remainder of the discussion. In the figures, frequencies associated with the codes are displayed by the letters “G” and “D”. The letter “G” represents the groundedness of the node, or the number of quotations linked to the node (Friese, 2012:140). The letter “D” indicates the density of the node, or the number of codes that are linked to the node (Friese, 2012:140).

Twenty-one students gave their consent to participate in the research in the first meso-cycle (MC1). The interventions that were applied in each meso-cycle were discussed in chapter 4 (see section 4.2.2.5) and were summarised in Table 4.2 and Table 4.3.

5.1.1 Reporting on the experiences of participants after the first intervention of the first meso-cycle

After the first intervention of the first meso-cycle (MC1 INT1), participants wrote transfer tests (see section 4.4.1.1) and were interviewed (see section 4.4.2.1). Although the transfer tests were indicated as a quantitative data collection method (see section 4.4.1.1), the results of the tests will be discussed in this section, because these tests determined the selection of participants for the interviews (see section 4.4.2.1.1). The order of discussion of the results in this section will be to report on the results of the transfer tests, the factors that hindered or promoted transfer (research aim 4c), students’ experiences of implementation of the guidelines (research aim 4a), the effect of implementation of the guidelines on transfer of knowledge and skills (research aim 4b), and the effect of implementation of the guidelines on students’ SDL (research aim 4d).

5.1.1.1 Results of the transfer test after the first intervention of the first meso-cycle

The transfer test was part of the formative assessment of the module in which the research was done. The topics that were assessed in the transfer test after MC1 INT1 (see Appendix G) were creating database tables, defining data types and primary keys, creating relationships between tables in a relational database, and designing database queries. When working in relational databases, such as Microsoft Access, data is represented in various tables. Relationships between tables have to be created to simulate the real-world relationship of the various entities from a given scenario. For example, when designing a database to provide results of an athletics meeting, one team will have many athletes, and one athlete can compete in many events. These real-life relationships should also be indicated in the database design. A deep understanding of the real-world scenario, as well as application of it in a relational database, is therefore required. When designing queries, various conditions have to be programmed to provide information from data. In the scenario of an athletics meeting, for example, information

may be required of athletes that obtained first place for competing in field items. Another example could be to obtain information of all athletes between 13 and 15 years of age that broke the record for the meeting in their particular event.

All 21 participants that gave informed consent completed the transfer test after the first intervention (see section 4.4.1.1). Table 5.1 provides a summary of the results of the transfer test. Seven participants obtained more than 74% for the test, ten participants obtained between 50% and 74%, and four participants obtained less than 50%. According to these percentages, participants were grouped into “successful transfer”, “attempted transfer” and “no transfer” groups, to inform the selection for the interview process (see section 4.4.2.1.1). Factors that hindered transfer (research aim 4c) that emerged from the transfer tests and the interviews will be discussed in the following section.

Table 5.1: Results of the transfer test after the first intervention of the first meso-cycle

(N = 21)					
No transfer (< 50%)	Interviewed	Attempted transfer (50%–74%)	Interviewed	Successful transfer (> 74%)	Participated in focus group
4	4	10	5	7	5

All participants that completed the transfer test were invited to interviews. Four participants from the no transfer group and five participants from the attempted transfer group agreed to be interviewed in one-on-one interviews (see section 4.4.2.1.2). Five participants from the successful transfer group participated in the focus group interview (see section 4.4.2.1.3). A total of ten interviews were thus held, and 14 participants participated in the interviews. The results of these interviews will now be discussed. All participants that gave informed consent were numbered in random order. In the discussion, participants will be referred to by these numbers.

5.1.1.2 Factors that hindered transfer after the first intervention of the first meso-cycle

In this section, the factors that hindered transfer (addressing part of research aim 4c) after MC1 INT1 will be reported on. It should be noted that the focus of the discussion in this section is the factors that hindered transfer. Although participants also succeeded in transfer, successful transfer and factors that promoted transfer will not be reported on here. The discussion will first focus on general obstacles that hindered transfer, and then on obstacles that specifically hindered transfer when creating relationships and designing queries.

Figure 5.1 shows the general obstacles that prevented participants from applying transfer during MC1 INT1.

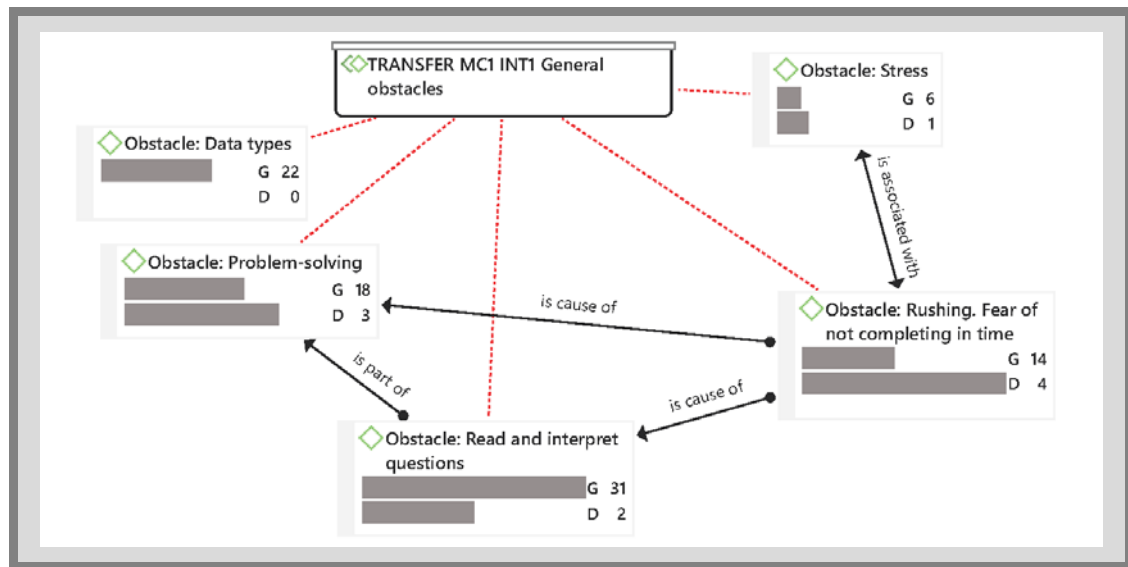


Figure 5.1: General factors that hindered transfer after the first intervention of the first meso-cycle

The nodes connected to the red dotted lines in Figure 5.1 indicate the main themes, or factors, that hindered transfer. A strong theme that emerged from the data was the obstacle of not reading and interpreting questions effectively. This theme was linked to 31 quotes (G = 31). Not effectively applying problem-solving strategies (G = 18) was another obstacle that emerged from the data, along with being rushed and fear of not completing the test in time (G = 14). Participants also experienced issues with data types (G = 22). Another factor that emerged was that participants experienced the test as stressful (G = 6). These factors, as indicated in Figure 5.1, will now be elaborated on.

5.1.1.2.1 Lack of problem-solving skills

A lack of problem-solving skills hindered participants from approaching given problems appropriately and from troubleshooting relationships that they realised were wrong and queries that gave the wrong output. Other obstacles, for example reading and interpreting questions, and rushing and fear of not completing in time, can also be associated with problem-solving issues, and they will therefore also be discussed here.

Some participants reported that they knew how to create relationships between tables and to design queries, but that they then encountered errors or wrong output and were unsure about which strategies to follow to correct the errors:

I didn't really know how to start [to correct the relationship]. It was the first time I had seen it make a one-to-one, and I wasn't sure why it did so. (P14)

But then he [the query] made many of those two. Like the same person over and over, and I didn't understand why he did it. (P20)

In other cases, participants lacked skills to verify if their solutions were correct:

I didn't know if I was right with that [my solution]. It was like that in the textbook. (P13)

Failure to properly read and interpret questions emerged as a cause of lacking problem-solving skills (see Figure 5.1). Participants reported that they did not read the questions properly, and they thus misinterpreted the questions or misread some of the instructions:

You read it as one sentence. You only maybe catch the first and the last part of the sentence. I missed it, and I lost a mark. It's unnecessary. (P23)

Before a query can be designed, a participant first needs to understand what should be done and then devise a plan to do the query and reflect on whether the output is correct. Not properly reading and interpreting the question could therefore also affect transfer when designing queries (see Figure 5.2).

How I thought I had to do it, what I understood, was about which date was the earliest, and that the surnames had to be in alphabetical order. So I thought the date had to be first, and then who was according to the surname on that day or date. (P12)

From the data it further emerged that participants did not manage their time effectively when doing the test. When they then eventually realised that they had misinterpreted a question, there was not enough time to correct the answer. Some participants, for example participant P14, only realised after the test that they had misread some questions and had therefore lost unnecessary marks, although they were actually capable of providing the correct answers:

These are things that I was able to do, but I stressed because I spent too much time on other things, and I didn't have enough time for this. (P14)

Participants attributed misreading of questions to being in a hurry, to being stressed, and to trying to work fast to complete the test in time:

It's because I worked too fast. I just forgot about that. (P15)

Yes, and then I was rushed. That was my biggest problem. (P18)

Being rushed thus emerged as a cause of not reading and interpreting questions properly, which, in turn, is viewed as part of problem-solving (see Figure 5.1):

Once again, I didn't read the question. (P12)

5.1.1.2.2 Factors that hindered transfer when assigning data types to fields

Participants reported that they were aware of data types and field sizes, but could not always explain why they did not indicate the data types of all fields accordingly in the test. Participants were not consistent when assigning field types and sizes, and they often ignored some fields:

The field sizes, for example the title, I don't know why I made them so big. (P11)

Like, for example, the cDay [field]. I just completely forgot to make this a short date. (P15)

Participants were aware of the various data types, but they did not assign them correctly, or they did not understand how to assign the data types:

I thought the field isn't that long, then I just made it Integer, and not Long Integer. (P20)

I'm a bit confused with Long Integer and the short and such, and then also with Byte. I'm not always sure when... There I forgot a bit when to use the Byte or so. (P14)

And where you decide if it's a Byte, an Integer, or Long, that I'm still struggling with. (P17)

Participants sometimes misinterpreted the data and assigned the data types incorrectly, for example assigning a number type to an address field, because the address contained a number, as described by P11:

I said that an address is a number and an Integer, because like the length and such of an address. Some differ. Some are longer, and some are shorter. And house numbers have a "6290", for example, in some places, and not like other people, for example, that only have "55". So that's why I made it a number. (P11)

Participant P12 knew about the various data types and could describe some correctly, but confused the Integer type with data types associated with decimal numbers:

Here I forgot what we had said about Long Integer and Byte. Byte, I remember, is very small, and Integer is commas [decimals]. But in the test I couldn't remember that. (P12)

Examples of negative transfer (see section 2.2.3.1.1) emerged. Participant P19 realised that cell phone numbers were long numbers, and therefore assigned a Long Integer data type, instead of text:

I was just thinking broadly. You get numbers that are longer than ten digits. So I just thought that you never know. So it was just out of... thinking out of the box. (P19)

P18 reported that not assigning the correct data types prevented her from creating the relationships correctly:

I thought, for example, one doctor has many patients, but when I tried to connect the patient and the doctor, it didn't work, because it wasn't the same data type. I understood the concept, but to have the correct fields... have the correct data types was a problem for me. (P18)

All the above factors are described as general factors that hindered transfer, and they will thus also be obstacles to transfer when creating relationships and designing queries. Other factors that are specifically associated with hindering transfer in creating relationships and designing queries will now be discussed.

5.1.1.2.3 Factors that specifically hindered transfer when creating relationships

It wasn't always the case that participants didn't understand the concept of relationships. Participants could often explain the relationships in real-life contexts, and they reported that they understood the scenarios. However, creating relationships is a complex task (see section 2.3.1), and several underlying elements have to be mastered. Various factors can thus hinder

Specific factors that hindered transfer when creating relationships emerged as (a) issues with primary keys (G = 4), (b) identifying fields to connect (G = 17), (c) deleting incorrect relationships (G = 8), (d) understanding the purpose of relationships (G = 6), and (e) conceptualising scenarios (G = 2). General factors such as problem-solving issues, and issues with data types, which have already been discussed in sections 5.1.1.2.1 and 5.1.1.2.2, are also viewed as obstacles to transfer in both creating relationships and designing queries, and are therefore also indicated in Figure 5.2.

(a) Issues with primary keys

Primary keys are integral fields when creating relationships. Thus, not being able to identify primary keys and not being able to delete a primary key when an incorrect field has been indicated, hindered participants from creating correct relationships:

Because with the relationships, I thought when I did them that had to be the primary key, but when I thought about it afterwards, I remembered that they had to be of the same information that you get in two fields. (P12)

And then the relationships. I knew dCode had to be the primary key, but then I changed it, and then I didn't know how to delete the primary key. (P15)

(b) Identifying fields to connect in the relationship

A strong theme that emerged was that participants found it a challenge to identify which fields in two tables to connect in order to create the relationship. Although participants reported that they understood the concept of a relationship, not being able to identify the fields to connect prevented them from creating the relationship:

Each patient has an ID number, so for each, how can I say? [For] each ID number there can be more than one consultation. That's how I saw it. But I didn't know how to link them to each other. I know the relationships, but I couldn't detect what to connect. (P13)

That was more or less how I saw it. But I didn't really know how to connect them. (P14)

(c) Not being able to delete wrong relationships

Participants reported that often when they realised they had created an incorrect relationship, they were not able to delete the wrong relationship, and they could thus not create a new, correct relationship:

My relationships were fine, but I didn't know how to delete the surname and the whole relationship. (P15)

And each time I wanted to delete the thing, it wouldn't delete. I don't know why. When I clicked on the relationship and I wanted to delete it, it wouldn't delete. (P18)

(d) Understanding the purpose of relationships

From the data it emerged that some participants did not yet understand the purpose of relationships (G = 6). Participant P12 reported that because she did not understand the reason why relationships had to be done, she could not understand the concept of relationships:

I struggle to understand relationships. Like the whole idea of why we should do them is really difficult for me to understand. (P12)

Participant P20 acknowledged that she did not understand what was going on in relationships. It is evident that because she did not understand relationships, transfer to convert the scenario to a relationship could not occur:

Because I don't have a clue what's going on [with relationships], I didn't think that far. If I go to a dentist I only sit and stress, and now you need to go further. (P20)

(e) Not being able to make connections to or conceptualise the scenario

Some participants could not conceptualise the scenario or make connections to the real-world scenario, and they thus could not create the relationship (G = 2):

I don't know if it's because I interpret it wrong, like I don't think about that, and if perhaps I think too superficially or too broadly, but I struggle to make the connections. (P14)

5.1.1.2.4 Factors that specifically hindered transfer when designing queries

Figure 5.2 further depicts the obstacles that participants experienced when designing queries, namely (a) formulating conditions (G = 9), (b) formulating conditions which includes grouping of fields (G = 7), and (c) having questions in Afrikaans and English but the data in English only (G = 2). General obstacles to transfer mentioned above (see sections 5.1.1.2.1 and 5.1.1.2.2) are also indicated in Figure 5.2, but they will not be discussed again in this section.

(a) Formulating conditions

Although participants understood what had to be done and what the output of the queries had to be, they entered conditions incorrectly and had difficulty in defining the criteria. For example, they confused the > (greater-than) and the < (less-than) signs, or they did not include the borders when specifying ranges. Participants thought they had programmed the conditions correctly, but they did not verify the output, and so they did not realise that they had made a mistake:

Oh, OK, OK. So I should rather put them next to each other. I must only put an "OR" in between, instead of going down. (P15)

The criteria... I struggled a bit with them... I struggle a lot with them. And then I don't know when to use a wizard and when I need to design it myself. (P17)

Participant P20 did not notice that the output was not according to the required criteria:

Oh no, but then there's also "26" and "34"! I didn't even notice. (P20)

(b) Grouping fields

Participants reported that they found it difficult to group fields in queries. They had an idea of what the output should be, but they thought they had to enter formulas or use Sum or Count functions. They tried to solve the problems by applying strategies or formulas they had used before (attempting transfer), without success:

Here I knew we had to do a formula. Or I thought you had to, but I couldn't do it, because the one I practised on was amounts that you had to subtract, and I didn't... and I tried to use Sum. But yes, I didn't know how to do it. (P12)

Then I thought, "OK, I have to put all the towns there are in the criteria, this or this or this. Then he [Access] will show it, and then the count." So that's how I approached it. Because with Group By you also said "Count". (P14)

(c) Having data in English only

Participant P11 reported that she was hindered by the fact that the transfer test was set in two languages, Afrikaans and English, but that the data in the database was in English only. No other participant reported on this issue:

We are used to reading the Afrikaans questions, then you actually search for the Afrikaans word in your mind, and then you translate what you have to search for in your mind, instead of only reading the English question first. I remembered I struggled a bit with that, to actually read the English question first and then look at the data immediately. (P11)

5.1.1.2.5 Conclusion on factors that hindered transfer after the first meso-cycle of the first intervention

In this section, factors that hindered transfer, as reported after MC1 INT1, were discussed. Figures 5.1 and 5.2 summarise all the themes where obstacles to transfer and possible causes thereof were experienced that emerged from the data. Possible causes of not being able to create relationships and design queries, and difficulties experienced with data types, are indicated. Factors such as a lack of problem-solving skills, being rushed for time, and defining data types impacted both the creation of relationships and the design of queries. Factors that emerged as obstacles to creating relationships were not being able to identify which fields to connect, issues with primary keys, deleting relationships, understanding relationships, and conceptualising given scenarios. When designing queries, participants indicated that formulating conditions, grouping fields, and not verifying whether the output of a query was correct hindered transfer.

In the following section, participants' experiences of implementation of the guidelines of MC1 INT1 will be discussed.

5.1.1.3 Reporting on participants' experiences of implementation of the guidelines in the first intervention of the first meso-cycle

In this section, the qualitative results will be discussed according to the research aims 4a, 4b and 4d. Codes were assigned to themes that correspond to the categories of the SRSSDL and the TLO (see section 4.4.1.2). Themes related to cooperative learning (CL), and positive and negative experiences of implementation of the guidelines, also emerged, and will thus be reported on.

Participants experienced the structuring of the module content positively. The module was structured so that participants first obtained an overview of all database objects and then studied each object in more detail (see Table 4.2):

I think it's good that we did a broad overview, because we saw the big picture. So I think the contact sessions help you to think more logically about a concept. Logical thinking about it, like "Why must I set up this relationship? What's it going to mean for me?" (P23)

Then later, when it's a bigger database, you don't get a fright, because "What's going on here now?" So it's better to throw yourself in at the deep end and then break it up into pieces than when you learn bit by bit. (P26)

Participants also reported that they enjoyed working on real-life scenarios:

And then in class we have a database that's realistic, and then ma'am tells us "Remember you want to do this because you have to draw connections" or "You are doing this one in order for you to have a perspective on this". (P24)

Participants further reported that they initially had a fear of Access, but that they now enjoy Access and have changed their mindset regarding databases:

I wasn't a fan of Access, I'll be honest. I didn't like it. At school I didn't like it. So you need to look at it from a different outlook. Then you're going to understand. I think that's what happened, because I must say, honestly, I like Access a lot more than I did. (P23)

I kind of like it. I was afraid, now I actually enjoy it, there's nothing I would change. (P13)

In the next session the qualitative results related to SDL will be discussed.

5.1.1.3.1 Qualitative results related to self-directed learning after the first intervention of the first meso-cycle

In Figure 5.3, the SDL node is connected to themes derived from the categories of the SRSSDL, namely learning strategies (G = 14), self-reflection (G = 11), identifying learning needs (G = 12), engaging in SDL learning activities (G = 18), and displaying interpersonal skills (G = 7), as characteristics of SDL. Identifying resources (G = 5) emerged as a theme, and it was accordingly added, because of its prominence in the definition of SDL (Knowles, 1975:18). Themes related to non-SDL characteristics also emerged from the data, namely blaming other factors (G = 10), a lack of interpersonal skills (G = 4), requesting direct teaching (G = 4), and not preparing for class and tests (G = 10).

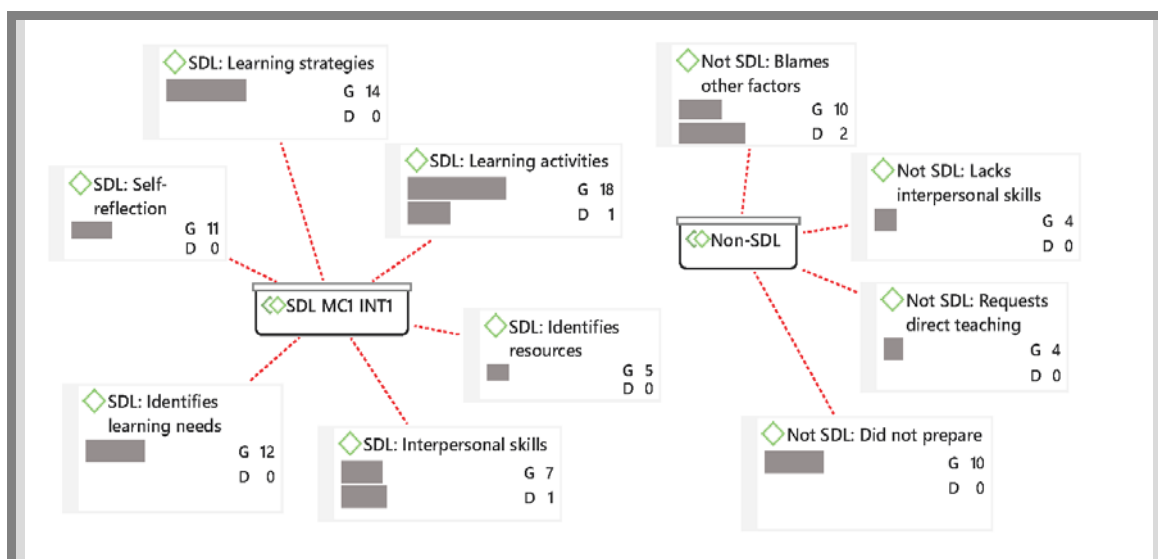


Figure 5.3: Qualitative results related to SDL after the first intervention of the first meso-cycle

Reporting will be done by first discussing SDL characteristics that emerged from the data. These characteristics will address the themes depicted in Figure 5.3. Themes on non-SDL practices and characteristics will then be discussed.

(a) Self-directed learning characteristics

Self-directed characteristics that emerged from the data were willingness to work with and help peers, working consistently throughout the semester, persisting when not understanding a concept, finding resources, doing additional work, reflecting on learning, and identifying learning needs.

P25 and P22 reported that they worked with peers on their assignments and explained concepts to each other:

We usually do them [assignments] together, and thus also teach each other. And concepts that we don't understand we can explain to each other. So that's also an effective method of working together. (P25)

And you help each other. I know how to explain to [name] so that she'll understand, and she knows how to explain a concept to me so that I'll understand. (P22)

Participants reported that they worked consistently throughout the semester and did additional assignments:

I won't only focus on what they ask me, but will also use other scenarios and then go through exam papers of past years, just to, for myself, compare the scenarios with each other and get more information. (P12)

If you do your preparation throughout the semester, it reduces the work you need to learn. [...] We realise it's to our own advantage, and that's why we prepare. (P25)

As preparation for the test, I also did additional assignments. So I think I did all the small assignments where you are taught step by step by myself. (P26)

Participant P23 reported that when she did not understand a concept (identified learning needs), she obtained resources and persisted until she had mastered the concept. Participants P13 and P24 also identified their learning needs and looked for appropriate resources to master the relevant concepts:

I couldn't understand the concept of a relationship, but when I sat down and wrote it out and pulled it apart and saw the database myself, I understood it better. (P23)

If I struggle with something, then I'll go to that chapter to find that section, see how they do it, and then see if I can get it right. (P13)

I did the things that I struggled with more than once, to make sure I knew what to do, and I also wrote them out in Afrikaans, because the English concepts can be difficult. (P24).

Along with identifying learning needs, the theme self-reflection also emerged from the data:

When I got home, I worked it out again, and I saw I made this mistake. [...] I will now learn from these mistakes. I'm glad I can, like, identify it myself, and that I can now focus on it. Like, I won't forget it again. (P14)

When we went through the memo afterwards, I could see where I made my mistakes, and I now know how to improve on them. It's very important for me to know where I made my mistakes and how I can improve. (P11)

(b) Non-self-directed learning practices and characteristics

Participants blamed other factors for poor performance, for example not being good at mathematics, not having had CAT as a subject at school, being stressed, that their memory stick broke, having a fear of Access, and that they were fourth-year students (a higher year group than the other students):

I have always struggled with mathematics. Up to Grade 10 I did well, and then I got a teacher that confused me, and from then on I've struggled with mathematics and everything. (P12)

I think it was stress and [...], because I didn't have it [CAT] at school. So I didn't have CAT at school, and I've never done Access, really. I did a bit in the first week, but now and then, as I have time, I prepare. But other times, if they [assignments] are not taken in or something, then, I must say, I don't prepare. That's my honest answer. (P14)

My memory stick broke this weekend, and then I started over. So... and then I got tired, and then I felt I'm going to go home. (P17)

Although some participants, like P14 above, indicated that they struggled because they did not have CAT as a subject at school (and thus had no experience with databases and Access), other participants who had had CAT at school also indicated that they feared the subject:

Because at school also, I don't know if it's a thing, but everyone had a block against Access. You fear Access, because you've never had anything to do with it. (P20)

Participants displayed characteristics that conflicted with their SDL characteristics. Participants P23, P25 and P26 were mentioned above as displaying SDL characteristics. They were, however, extrinsically motivated, in that they wanted class preparation activities to be handed

in. Participant P23 only wanted to work with certain students in class, which indicates a lack of interpersonal skills:

One of my viewpoints is, I will say, that preparation needs to be handed in. That will force the whole class to do their preparation. (P25)

I think she sees from my attitude that I'm a bit irritated with her, because I'm very explicit with my body language, like my face. If I don't like you, you'll notice it. (P23)

Some participants requested more direct teaching. Some wanted to be reassured of their understanding of the content, and others felt that they were entitled to be taught:

If ma'am can tell us that ten of us understands it like this, then ma'am must explain to us that it's not like this, because of such and such. (P11)

When I learn something new, I don't immediately want to work with someone that doesn't know more than me. I need that teaching. (P12)

Participants P12, P14 and P20 further reported that they had not prepared for class or for the transfer test, or for both:

Firstly, I could have prepared better. I didn't go through it thoroughly. I could have done more. (P12)

I didn't really go through the work. I must acknowledge I didn't work through it. (P14).

The self-preparation as well, you just do what's given. You don't have time, or you don't feel like it, then you don't go a step further. (P20)

In the following section, qualitative results of implementation of guidelines related to the categories of the TLO will be reported on.

5.1.1.3.2 Qualitative results related to the TLO after the first intervention of the first meso-cycle

Although qualitative results related to intrinsic motivation, self-efficacy, flexible learners, and learning independently are described in this section as part of the categories indicated of the TLO, they are also all integral to SDL (see section 3.4.1) and thus to DSDL. The themes that will be discussed in this section should therefore not be seen in isolation, but should be viewed with the other SDL characteristics discussed above. One of the categories of lifelong learning included in the TLO is transfer, which is an outcome of DSDL (see section 3.7). Qualitative results that emerged related to the theme “makes connections” are thus associated with transfer.

When creating the network view (see Figure 5.4), nodes referring to themes that correspond to the categories of the TLO were connected with the TLO node. Themes that emerged from the data can be associated with high and low categories of “self-efficacy”, “outcome motivation” and “flexible learner”. Codes were therefore created for “Self-efficacy: Good” and “Self-efficacy: Low”, “Motivation intrinsic” and “Motivation extrinsic”, and “Flexible learner” and “Flexible learner: Low”. Themes that are associated with high levels of the various categories are

indicated on the left-hand side of Figure 5.4. Themes that are associated with low levels of the various categories are indicated on the right-hand side of Figure 5.4. Themes also emerged indicating that some participants did not make connections. Thus, the theme “Does not make connections” was added to Figure 5.4. The themes depicted in Figure 5.4 will now be discussed.

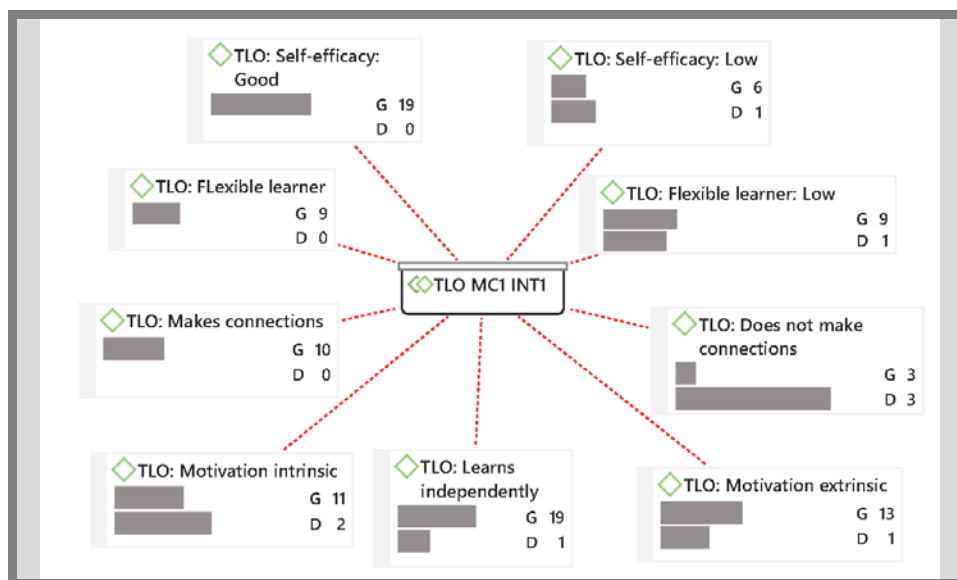


Figure 5.4: Qualitative results related to the TLO after the first intervention of the first meso-cycle

(a) Results for “self-efficacy”

Good self-efficacy emerged as a strong theme from the data (G = 19). Although P11 initially had a fear of the subject, she felt positive and her confidence increased once she could create a relationship:

I feel more positive about it [the module] and have more confidence towards the subject. Relationships I feared a lot. But I also got a lot of self-confidence when I got them right the first time. (P11)

Although some participants did not do well in the transfer test, their self-efficacy was still high. Participants also indicated that they felt confident that they could do better:

I feel I can do better. I can really do better than this, but this is now the first test, and then I just want to improve. I did learn for the test, and I worked through my textbook and did the exercises, but I can improve. But it's not bad. It's good. (P13)

I think I can... I know I can do much better. (P15)

Disappointed, I'll say. Disappointed. But I'll definitely use it as a stepping stone to get where I would like to see myself at the end of the semester. (P19)

Not displaying good self-efficacy (G = 6) emerged as a weaker theme from the data. Only comments made by participants P12, P17 and P20 could be linked to low self-efficacy.

Participants reported that they were unsure of themselves, because they found themselves in new terrain with the database module:

I was very nervous, and I think the fact that I was unsure of myself [...] affected me a bit. We hadn't done a test where you specifically say "Do this and this" or she would say "Do the relationships. Don't do this or this" or she would say "Make it from the foreign key to the primary key". So I didn't know it. (P17)

But everyone has a block towards Access. You're afraid of it, because you haven't done it before. (P20)

Participant P12 mentioned that working with a group member that was unsure of the content affected her self-efficacy. However, when she worked in a group with confident participants, it improved her self-efficacy:

Her lack of confidence affected me, and I started to doubt myself, whereas if I work with someone who is strong in the subject, it drives me to do better. (P12)

(b) Results for "flexible learner"

Simper et al. (2017:1166) associate flexibility in learning with participants' belief in themselves and the control that participants believe they have over their learning. Quotes that referred to applying various strategies for learning, where participants indicated that they exercised various strategies to master the content, believing that they could master the content, were thus coded as "flexible learner" (G = 9):

I specifically looked at examples on the Internet, watched videos on YouTube and so on, on how relationships are created, in order to prepare myself, so that I could know what to expect in possible situations and how to do it. (P11)

We come together at a certain time in the week, and then we work together. When one of us doesn't understand, she explains to the other. And then we'll go onto the Internet. Sometimes we struggle. If there's someone like [name], then we'll always ask. If we can't get it right, we'll wait till the next class and ask someone. Like in Wednesday's class I worked with [name]. I didn't understand the Lookup Wizard and the Input Mask, and she explained to me how they should be done. (P17)

From the data it further emerged that not being a flexible learner (G = 9) militated against interpersonal skills and resulted in negative experiences of working in groups. Some participants reported that they experienced some group combinations negatively, namely being grouped with participants whom they do not know, or being grouped with someone who argues about the work or who does not know what is going on in the subject. These comments were coded as not being flexible in learning:

So I think it was scary for me to immediately work with someone that I didn't know, because for me it was also a new... Although I sort of understood before what was going on, when I suddenly had to help someone, I started to stress. So I think what puts us off is those sudden new groups, and then especially when they come with new work. [...] It's also my own fault, because I... I don't give myself a chance to learn new stuff or to expand. My brain stays on what it has learnt, and then as soon as something new comes in, I again struggle to adapt. (P12)

I've experienced it before. You're grouped with someone who doesn't know much, and they argue the whole time about it. Like I'm not going to mention names, but there's someone in class all of us don't want to be in a group with, because she argues the whole time, and you don't finish, because you first need to explain to her what's going on. (P15)

Participant P26 did not want to be grouped with participants that were not in her circle of friends, which can be interpreted as not being a flexible learner:

It's not necessarily nice to work with a... this sounds awful... to be grouped with a stranger. We are third-years. You have your friends, you have your groups. If I don't know you in my third year, then I'm sorry, I'm not interested. (P26)

Based on the above, not being flexible in learning was also associated with a lack of interpersonal skills and not being willing to work in groups with all peers.

(c) Results for “learns independently”

“Learns independently” emerged as a strong theme ($G = 19$) (see Figure 5.4). Participants from all groups identified by the transfer test – the no transfer group (P11), the attempted transfer group (P13), and the successful transfer group (P25) (see Table 5.1) – reported that they experienced implementation of the guidelines positively. Participants were therefore encouraged to learn independently, or to organise their learning, as interpreted by Simper *et al.* (2017:1169), to ensure that they mastered concepts and were prepared for class:

In a way it was nice, because if you struggle on your own a bit and you see on your own how to do it, then you get it right at the end, and if you get it right, then you feel glad that you could do it on your own, and that you're not being spoon-fed, and you know you can also take the initiative and see what's going on. (P11)

I made notes. So as I went through the notes, I went through the textbook and looked in the study guide which exercises to do for that chapter. So I worked through the exercises in the textbook, and I went through the notes and my textbook from the beginning, with all the steps. (P13)

One doesn't always have time to do everything before writing an exam, so when you do your preparation during the semester, it's to your advantage. We realise that it's to our advantage. So that's why we prepare. (P25)

(d) Results for “makes connections”

Participants reported making connections between the given scenario and creating relevant relationships ($G = 10$):

I dragged him [the relationship] from the patient number to the consultation ID. Because I thought for every patient number there are infinite consultation IDs. (P14)

Participants P13, P14 and P20 reported that they sometimes found it difficult to associate the scenario with the relationships. This was coded as not making connections ($G = 3$):

I don't know how to really see it, and when I had to make the other relationships with the dentist, then I also struggled a bit. I don't know if it's because I interpret it wrong, like

thinking about it but not thinking of everything, or whether perhaps I think too superficially, and not broadly enough, but I often struggle to make the connections. (P14)

(e) Results for “motivation”

The theme of extrinsic motivation ($G = 13$) emerged slightly stronger from the data than the theme of intrinsic motivation ($G = 11$). Comments about obtaining good marks or doing assignments because they will count for marks were linked to extrinsic motivation. Most of the quotes associated with extrinsic motivation were made by participants in the focus group interviews (P22, P23, P24, P25, P26), who obtained good results in their transfer tests:

Especially for us who are motivated to do well, as your marks motivate you. Because it's not nice to see “OK, now I have 88”. Now you write again, and “Oh, now I have 70”. (P25)

When you submit your preparation, what's the use if it doesn't count for marks? (P26)

Participants P11, P12, P13, P14 and P25 made comments about enjoyment of learning, which were linked to intrinsic motivation. Participants reported that they enjoyed the teaching strategy, doing the activities, and coming to class prepared. Some comments on enjoyment were also linked to CL, and they will be reported on in section 5.1.1.3.3.

It [the teaching strategy] is quite nice for me. I was a bit scared, and now I actually enjoy it, so there's nothing I would have changed. (P13)

Participant P13 also reported that she prepared for class, because she wanted to know what is going on in class, and she feels organised and up to date with the work when she is prepared:

If I'm prepared, then I know what's going on in class. But if I'm not prepared, then everything is just too disorganised. Then I feel I'm behind. So if I prepare, it's better for me. (P13)

Participant P25 mentioned that she found Access to be an enjoyable experience:

I now enjoy the experience much more than I did at school. I'm very glad that I've changed my outlook. I never understood why we had to learn this, and now for the first time I do. So I also enjoy the subject a lot. (P25)

Participant P14 mentioned that she enjoyed doing the activities, because after working in a group setting in class, she understood how to do the assignments:

It helped me a lot to understand it better. And then when we did the activities, ma'am also handed out the pages and let us work in the groups and stuff. Well, then I know it works, and I get it right. Then it's nice for me, and then when I sit down and I have to do the assignment for Friday, then it's actually nice for me. (P14)

In this section, themes related to the TLO that emerged from the data were discussed. In the following section, participants' experiences of CL will be reported on, to further address research aim 4a.

5.1.1.3.3 Experiences of cooperative learning after the first intervention of the first meso-cycle

The themes that emerged related to CL (see Figure 5.5) were positive experiences of CL (G = 27), individual accountability (G = 7), positive interdependence (G = 3), issues with group combinations (G = 7), and negative experiences of CL (G = 13). In section 5.1.1.3.2 it has already been reported that participants who experienced working in groups negatively were also associated with not being flexible in their learning. These themes as depicted in Figure 5.5, will now be reported on.

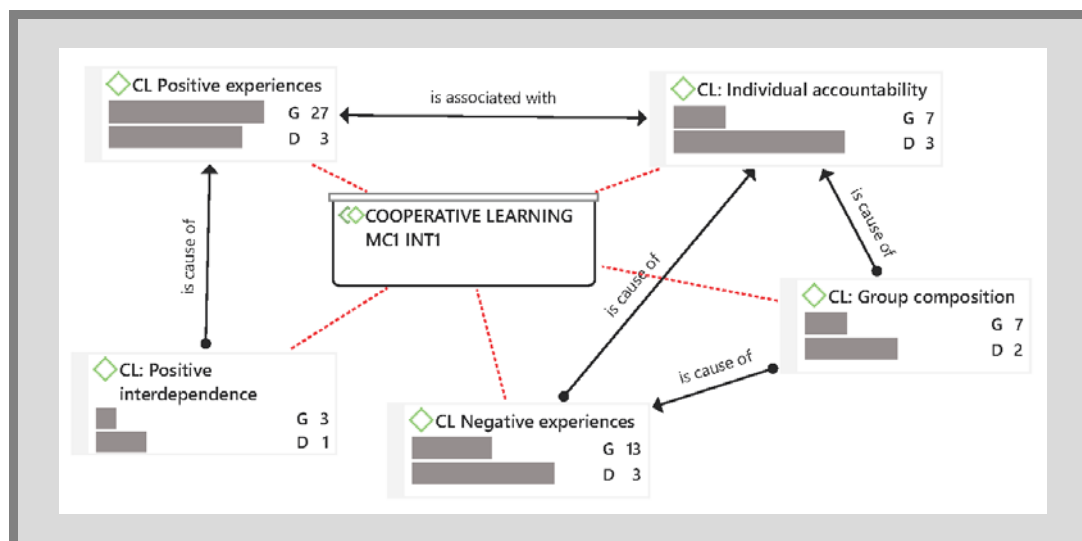


Figure 5.5: Qualitative results of participants' experiences of cooperative learning

(a) Positive experiences of cooperative learning

Comments that can be related to positive experiences of CL (G = 27) exceeded comments related to negative experiences (G = 13). Especially where groups functioned well and elements of positive interdependence (see the comment by P17) and individual accountability were present, positive experiences of CL were reported:

Because when you work on the activity in groups, you are like forced to do it, and then it's easy. When you understand something, you can explain to that person, or that person can explain to you. So I enjoy it so far. It feels like I'm learning something. Like I can feel each time I was in class, no, I learnt this, and I know it, and so on. (P14)

I hate group work. But it was nice, because [name] was kind when I didn't understand. She had a lot of patience for me, and when I didn't understand she explained to me, and when she didn't understand I explained to her. (P17)

The group work... I like the group work, because for me... many times you don't know, and you struggle on your own. Then we can help each other. (P20)

Participants mentioned that they felt that learning took place in class and that they obtained a clearer understanding of the work during contact sessions and interaction with their peers:

It's a nice classroom environment, and you feel at ease. And then we could do it. It was nice, because I knew what was going on. And for the next questions you are nicely on top of them, because I did the preparation. It's difficult, but I also like working in groups. (P12)

Ma'am divided us into groups, and I worked with [name], and she didn't understand relationships. When I explained them to her, she thanked me like a hundred times. I enjoy working in groups. It always works. (P25)

(b) Negative experiences of CL

Negative experiences of CL were attributed to participants or members of their group not being prepared, or because of language issues or working with students they did not know. Participants mentioned that they wanted to choose their own group members rather, and that they preferred working with patient peers and their own circle of friends:

I feel groups should be divided according to... like you should be with someone who is patient, and like rather with friends, if I can say it like that, than with a friend that performs poorly and a friend that performs well. Because if you're with someone that you don't know, you get irritated. (P15)

So it's definitely... I think to be grouped with the person that you work best with is more effective and you are more productive than being grouped with a stranger. (P23)

Participants from the successful transfer group especially had mixed opinions about CL. When working with students who were prepared and willing to learn, they enjoyed working in CL groups. They, however, reported that they found it difficult to work with students who were not prepared and who did not show interest in the work. They further mentioned that such group members often relied on their knowledge, and they felt that they did not experience learning gain. The comments indicated that positive interdependence and individual accountability did not feature strongly in such groups:

There are like some people who don't prepare, or who do nothing, and then it doesn't help being in their group, because you can just as well do it on your own, because they rely on your knowledge only. (P20)

It's like a bit of both. Sometimes you enjoy working with someone. Other times you feel like you want to shake that person, like "Just focus. We can't spend forever on this". (P23)

Negative experiences can also be related to a lack of interpersonal skills. P23, for example, mentioned that the attitude of some group members irritated her:

I was put in a group with her. It was like she didn't care, because she told me that she'd taken this [module] the previous year. "Hopefully I'll get it right this time." Then I thought to myself, "This isn't the kind of attitude I can work with." It irritated me on the spot. (P23)

(c) Negative experiences fostered other competencies

Although students did not enjoy working with some other students, and although they felt out of their comfort zone because they did not know which students they were going to be with in a group, it sometimes motivated them to prepare better for class. In such cases, as mentioned by P12 below, individual accountability was fostered:

And when I worked with her, I understood before what to do, and the more she tried to do it differently, the more it confused me. But this week I prepared much more thoroughly, because last week I didn't have such a nice group member. (P12)

I struggled a lot. I had to translate it, because when she said something to me in English, I had to say it to myself in Afrikaans, otherwise I wouldn't understand her. (P21)

Participant P25 from the successful transfer group acknowledged that working in a difficult group setting with someone who did not show much interest was also a learning experience:

If you see she wants to learn, and she wants you to help her, then one would do it any time. But it's now just like... we were both in such a situation where we were working with a person who didn't show any interest. Then you struggle. But that's how we learn. (P25)

5.1.1.4 Adjustment of guidelines after the first intervention of the first meso-cycle

For MC1 INT1, the guidelines as suggested in Table 4.2 were applied. The qualitative results indicated that although participants reported SDL characteristics and attitudes, they also still displayed non-SDL characteristics and attitudes (see Figure 5.3), were often extrinsically motivated (see Figure 5.4), and could improve on their group skills (see Figure 5.5). Inability to do problem-solving was identified as a strong factor that hindered transfer. Also, participants experienced many obstacles in creating relationships and designing queries (see Figure 5.2). Participants further required more exposure to assigning data types (see Figure 5.1).

For the second intervention in the first meso-cycle (MC1 INT2), to address the above, it was therefore decided to give participants the opportunity to design their own scenarios, by giving them an authentic task to do (guidelines U and V; see Table 4.2). According to the proposed guidelines (see Table 3.6), an authentic task could assist participants with transfer and allow them more control over the learning content that has to be studied, thus developing their SDL. Participants would also be granted more opportunities to practise skills such as troubleshooting and handling problem situations in real-life environments (see Table 3.6). Participants were thus encouraged to create a database scenario of their choice that they could personally relate to, and to develop a full database solution for the scenario. Due to limited class time, the authentic task would be done individually, out of class. Participants would thus not be burdened with the additional logistics of arranging group meetings, and social loafing would not be possible, as each participant would be individually accountable for their project.

All guidelines as proposed for MC1 INT1 (see Table 4.2) would still apply in MC1 INT2, with the addition of the authentic task as an individual database project to be done out of class time. Participants would in the second intervention continue to work in CL groups and cooperative pair programming groups in class, to improve their group skills, and also their SDL. Apart from engaging in new content, participants would be required to critically evaluate each other's

planning for their projects. Opportunities would also be created to discuss the progress of the projects, as well as problems that individuals experienced with the projects in their CL groups.

To further explain the second intervention to be applied in MC1, some background on database design needs to be given. Designing a database is a complex process involving many steps. In the second intervention, participants were introduced to entity relationship diagrams (ER diagrams) (see Appendix K) and normalisation of tables. An ER diagram can be defined as an abstract representation of a given scenario, indicating the various entities and their relationships as derived from the given scenario, using specific visual notations (see Appendix K). ER diagrams further have to be refined, so that no many-to-many relationships between entities exist. From the above discussion, the importance of being able to transfer knowledge of ER diagrams and normalisation to various real-life scenarios should be evident.

One purpose of normalising database tables is simply stated to eliminate redundancy of data. Existing database tables will usually need to be divided into many tables, according to the entities depicted in an ER diagram. Primary keys then need to be assigned, and, finally, relationships between the various tables need to be created. Only after normalisation can the database be created in database application software such as Microsoft Access.

The first step in the process of database design will thus be to draw an ER diagram and create normalised tables. ER diagrams and normalisation were only included in the second part of the database module. The reason for this was that participants first needed to have in-depth conceptual knowledge of databases before they could design abstract representations of databases (see section 2.3.1.3). The aim was to reduce the cognitive load (see section 2.3.1.3) when engaging in these abstract designs, by building on existing schemas about databases in the long-term memory of participants, to ultimately increase transfer (see section 2.3.1.4).

In the following section, participants' experiences of MC1 INT2 will be reported on.

5.1.2 Reporting on participants' experiences of the second intervention of the first meso-cycle

After MC1 INT2, another transfer test was written (see section 4.4.1.1), and interviews were held with willing participants (see 4.4.2.1). In this section, reporting will first be done on the results of the transfer test, then on the factors that hindered transfer (research aim 4c), and lastly on participants' experiences of implementation of the guidelines (research aim 4a).

5.1.2.1 *Results of the transfer test after the second intervention of the first meso-cycle*

All 21 participants that gave informed consent wrote the transfer test after MC1 INT2 (see Appendix H). The topics assessed in the test were normalisation, drawing ER diagrams, and

creating relationships. The results of the test are summarised in Table 5.2. Six participants obtained less than 50% for the test, 13 participants obtained between 50% and 74%, and two participants obtained more than 74%. As there were only two participants in the successful transfer group, no focus group interview was held. All the participants were therefore invited to one-on-one interviews.

Table 5.2: Results of the transfer test after the second intervention of the first meso-cycle

(N = 21)					
No transfer (< 50%)	Interviewed	Attempted transfer (50%–74%)	Interviewed	Successful transfer (> 74%)	Participated in focus group
6	1	13	4	2	0

Only five participants accepted the invitation for interviews. One participant from the no transfer group and four participants from the attempted transfer group were interviewed. No participant from the successful transfer group accepted the invitation to be interviewed. The low number of participants that was interviewed could possibly be attributed to the time of the year. At that time in the semester, participants were almost done with classes, the end-of-year examinations were drawing near, and participants were pressed for time to finish all their required assessment tasks in their various modules.

In the following sections, the factors that hindered transfer that emerged from the interviews, and participants' experiences of the guidelines, will be reported on. Participants that gave informed consent were randomly numbered. These numbers will be used in the discussion below.

5.1.2.2 Reporting on factors that hindered transfer after the second intervention of the first meso-cycle

The discussion in this section will focus on the obstacles that hindered transfer when participants had to draw ER diagrams and normalise database tables.

From the data it emerged that participants were at this stage more comfortable with creating relationships between tables. Participants reported that when doing their project (the authentic task) (see section 5.1.1.4), all the concepts that they had learnt had to be taken into account and were thus enforced:

I have to say now they [relationships] are easier for me, especially after our project we did, because you had to do them all the time, and you realised all the time, "My fields should be the same. This should be the same. It becomes like second nature." (P4b)

Another theme that emerged was that participants found the new topics of normalisation and drawing ER diagrams challenging and complex. What added to the complexity of the work were the various views and interpretations that fellow students in the CL groups had on the scenarios and the solutions:

But the questions, I think everyone understands them differently. (P1b)

You have to sort it out. Every situation is different. You can't learn it, or I suppose you should, but every scenario will be different, so you can't go ahead and learn with a pen and paper, because it will be different. (P2b)

Participants could describe what normalisation was, and they understood the scenarios, but they reported that it was challenging to apply normalisation from a given scenario, or to explain normalisation in their own words:

If you have to put real-life things into your database, then it's hard not to repeat or normalise it. It was very difficult for me to do. Because, for example, with mine [my project], there's going to be more of... there will be more of certain animals on one farm, for example, but you can't like repeat it. Everyone must have their own identity. There can be two or three workers working on one farm, but you can't repeat the name either, because that's not normalised. So I understand the concept of normalisation, but applying it to the real situation is difficult for me. (P3b)

All concepts learnt before, such as assigning primary keys and creating relationships, also had to be taken into account when normalising tables:

Normalisation, in capital letters. I don't know. Sometimes the concept doesn't make sense to me. Like that one database of CDs and tracks. I still don't understand it. I just can't understand it in my mind. It should... I don't know. I don't know how to create those tables and organise them, and then you still have to choose which one will be your primary key, and you should choose the right one to draw your relationships. There's something that just doesn't make sense to me. (P2b)

Participants reported that they could interpret a given ER diagram and that they understood the concept of ER diagrams and the scenarios, but that they found it difficult to draw ER diagrams:

OK, it's definitely the diagrams. Especially when it comes to their interpretation, drawing them. Reading them isn't so hard for me, because it's easy to read them and convey them. But drawing them from a scenario is sometimes a bit difficult for me, because each person interprets them differently when we debate in class. And that's why it's hard for me every time. Because each time when I think I'm right, I've interpreted it wrong. (P4b)

In the following section, specific factors that hindered transfer when drawing ER diagrams and normalising database tables will be discussed.

5.1.2.2.1 Factors that hindered transfer when drawing ER diagrams and normalising database tables after the second intervention of the first meso-cycle

Figure 5.6 depicts the factors that hindered transfer in drawing ER diagrams and normalising tables. The complexity of these tasks is displayed by the many factors that could hinder transfer, and the interrelated connections between these factors. As the focus is on the factors that

hindered transfer, reporting of participants' successful transfer attempts will not be done in this section.

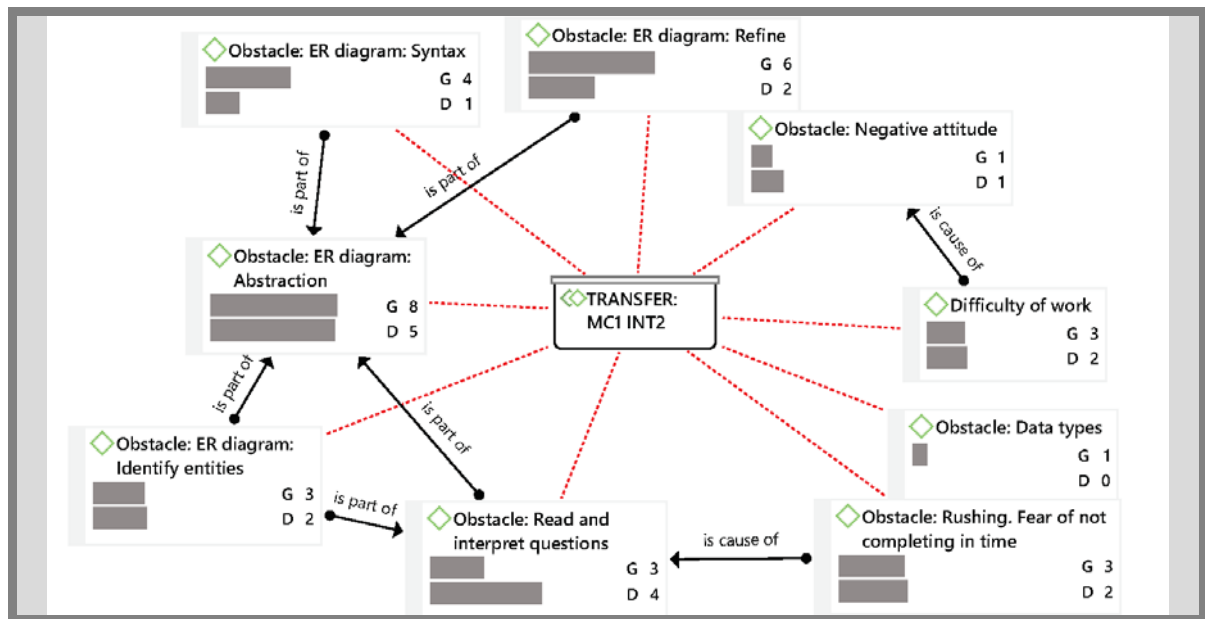


Figure 5.6: Factors that hindered transfer after the second intervention of the first meso-cycle

When participants described their thinking when drawing ER diagrams, they reported that they were comfortable with the given scenarios and were able to describe the relationships between the various entities. They understood the concept of normalisation and could describe its meaning. A strong theme that emerged was that it was challenging to depict the relationships as an exact abstract diagram ($G = 8$) and to use the correct syntax ($G = 4$) when drawing the ER diagrams. Participants also reported that they neglected to refine many-to-many relationships ($G = 6$). A theme that again emerged (see section 5.1.1.2) was that participants were rushed for time ($G = 3$), and therefore made unnecessary mistakes.

Weaker themes that emerged were that negative attitudes developed ($G = 1$), because of the difficulty of the work ($G = 3$). Some participants mentioned that they did not interpret the questions correctly ($G = 3$), and one participant reported that she had issues with data types ($G = 1$). The aspects mentioned above will now be discussed in more detail.

(a) Identifying entities and refining many-to-many relationships in ER diagrams

Participant P1b used the scenario of a salad shop for her project. She understood the scenario, but could not determine which entities to put in the diagram:

I think that's because from such a small scenario you can use many things to make an ER diagram. Like I didn't know should I take salad, business, a bowl, or the codes? I didn't know what to take. (P1b)

P3b explained that she could place the entities she had identified in the scenario in an ER diagram, but that the problem was to add another entity to refine a many-to-many relationship:

I understand the concept of it [an ER diagram], like the one-to-one and the many-to-many, and so on, but I, for example, only use the entities that are there, and to have insight, to put in an extra one, will make it easier or just change the scenario or so. (P3b)

Participants reported that they knew that their diagrams should not have many-to-many relationships, but instead of refining the many-to-many relationships, they just indicated them as a one-to-many relationship, because either they could not refine the relationships or they decided to leave them as they were:

But it didn't feel right for me to do so [to indicate them as many-to-many relationships], because we always said there should be no many-to-many relationships. (P4b)

However, when participants created the tables in Access according to the design of the ER diagrams, they refined the many-to-many relationships, added the required entities, and created the relationships correctly. When participant P1b was asked why she applied the scenario correctly in the database but not when initially designing the ER diagram, she replied that she knew what to do but did not do it.

(b) Abstraction and adhering to the syntax of ER diagrams

Participants did not adhere to the required syntax when drawing ER diagrams, and thus their diagrams did not represent their understanding of the scenario. Participant P1b was able to explain the relationship correctly in her own words, but she did not use the correct syntax in the ER diagram. Participants P2b and P4b reported that they struggled to make an abstract representation of the scenario, although they could explain the relationships and could interpret ER diagrams:

The scenario is fine. I understand it when it's clearly set out. Then it's not difficult to read. I understand that concept. But now to draw it is a bit difficult. (P4b)

Participant P3b reported that she overcomplicated her design, although she logically understood the scenario:

I can see it logically, [...] I don't know what happens. It's just like when you have to reproduce it. Then you get confused, or you make it difficult for yourself. (P3b)

(c) **Rushing to complete the test in time**

As also reported in the results of MC1 INT1 (see section 5.1.1.2), participants indicated that they made mistakes because they were rushed for time. Reading scenarios and then deciding on entities and relationships before drawing ER diagrams was a time-consuming activity:

I think time caught up with me. Yes, I sat too long figuring it out. I wanted to go back, but then there wasn't any time left. Then I thought, "I'm going to leave it that way. I'll get some marks somewhere. It's better than nothing." (P1b)

(d) **A negative attitude**

When participant P2b was asked what she thought prevented her from getting the answer right (hindered transfer), she replied that it was her negative attitude:

I think my attitude towards them [ER diagrams]. Because right from the beginning I didn't understand them, and I just couldn't get them right. The concept wasn't right. I went into it with the wrong attitude. And one shouldn't reason like that. (P2b)

In this section, factors that hindered transfer after the second intervention were reported on. Participants' experiences of implementation of the guidelines will now be reported on.

5.1.2.3 **Reporting on participants' experiences of implementation of the guidelines in the second intervention of the first meso-cycle**

Figure 5.7 depicts the experiences of participants of the guidelines implemented in MC1 INT2. When viewing Figure 5.7, it should be kept in mind that only five participants were interviewed (see section 5.1.2.1). Overall, participants reported positive experiences of implementation of the guidelines (G = 5). The red dotted lines connected to aspects of CL in Figure 5.7 indicate that experiences of guidelines were often related to CL. The main themes were that participants were exposed to different views (G = 5) and experienced CL positively (G = 3). Participants mentioned the complexity of the tasks when having to normalise database tables and draw ER diagrams (G = 3). Their comments on the challenges of these concepts have already been addressed in section 5.1.2.2. The experiences depicted in Figure 5.7 will now be discussed.

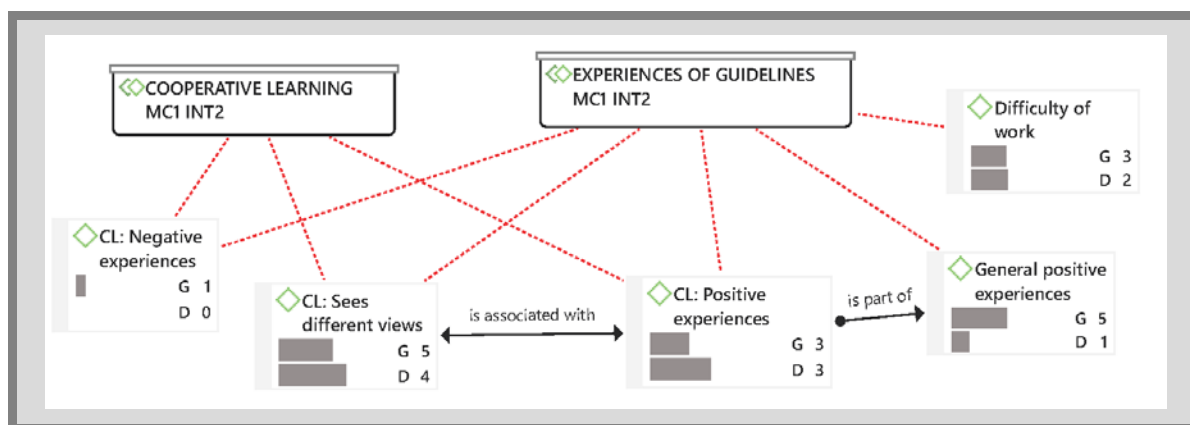


Figure 5.7: Experiences of implementation of the guidelines in the second intervention of the first meso-cycle

Participant P3b mentioned that she found immediate application of the theoretical part of database design sufficient, and that it contributed to identifying problems that she experienced with the concepts. Participant P4b reported that the constant repetition of difficult concepts, such as relationships, helped with retention and problem-solving:

It was sufficient for me, the theory, and then to immediately apply it and see where your problems are, and then pay attention to those. (P3b)

The class was nice for me. It was a lot of work, but I mean if we didn't do something every day, we would have fallen behind. (P5b)

Access I feel it was very good, especially that we constantly practised and repeatedly... repeated it. For example, relationships, which are really difficult. We've done it so many times, so that by now you say the rhyme in your head: "If you create a relationship and it doesn't work..." Then you remember, "OK, but this and this and this should be the same, so maybe I just have to go look. Maybe this is why it isn't working." (P4b)

In the following section, themes related to CL as depicted in Figure 5.7 above will be elaborated on.

5.1.2.3.1 Experiences of cooperative learning in the second intervention of the first meso-cycle

Participants reported that they enjoyed and appreciated working in groups. Participants reported that they found it beneficial to see the different views of other participants ($G = 5$), and that they learnt from each other:

And then you hear how that one explains it to you and how the others explain it. So then you hear different opinions, and each one explains it in a different way, so you can take a little bit of it and put it together. And then you make it your own. So it helped a lot. So with this, I would recommend group work. (P2b)

Yes, all the activities we do and group work always help, because this person sees it like this, and I see it like that. Then it's a lot of information. (P1b)

We had to work together in a group, and we all sat together. And then this one gave an opinion, and that one gives an opinion. And then together you see, "Maybe this makes more sense than that one, and that guy sees it differently." Then it made a little more sense to do it with someone else who thinks differently from how I think. Because what I think isn't always necessarily right. But what others thought might be right. And when she explained it to me, I understood better. So it was better for me when someone was there to go through the concepts with me and tell me, "But here it is, how I think, and that's why I think so." [...] "Yes, maybe I should look at it from another side as well." (P4b)

Only participant P4b had a negative comment. She found it a bit frustrating when she sometimes had to work with students in groups that were not serious about their studies. She, however, also indicated that at other times the group helped her to obtain a broader view:

But it feels to me as if they don't always want to work. They're just there because they're there. So it's frustrating sometimes. But other times I felt it was really... working in groups also helped. Because the person thinks differently from how you think. And it also helps you to get a broader perspective and not just look at the same thing over and over with blinkers on and approach it the same way each time. (P4b)

In the following section, the qualitative results of participants' experiences related to SDL will be discussed.

5.1.2.3.2 Qualitative results related to self-directed learning after the second intervention of the first meso-cycle

Figure 5.8 provides an overview of themes related to SDL that emerged from the data. Participants reported on SDL characteristics and activities that they mostly attributed to the project that they did (the authentic task). They applied SDL learning activities (G = 10), identified their learning needs (G = 7), and identified resources (G = 3). Participants also mentioned non-SDL activities (G = 5), which will be elaborated on in the discussion below.

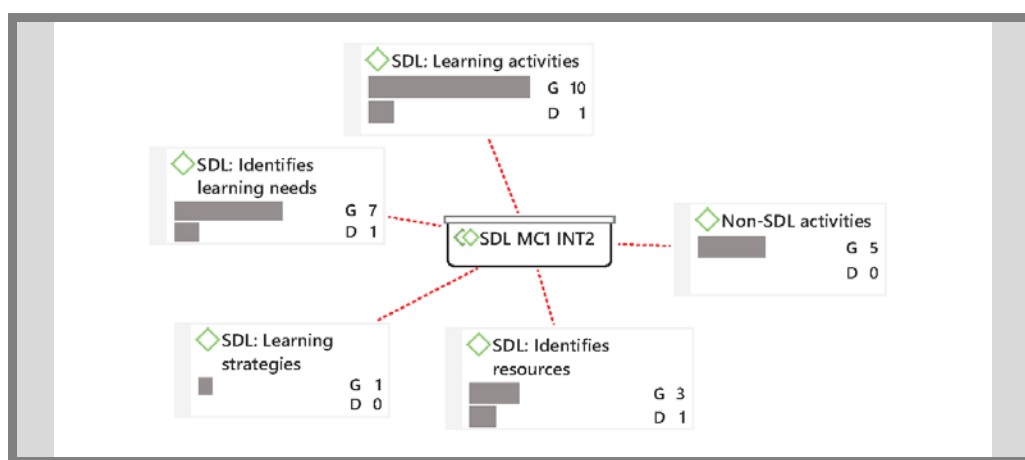


Figure 5.8: Qualitative results related to SDL after the second intervention of the first meso-cycle

Participants further reported that while doing the project, they identified their learning needs:

When I looked at the rubric, I thought, "Ag, why didn't you think of that?" But I understand now. When I went through the rubric and saw where my mistakes were, I realised, "OK, but I could have done it like this or like this." (P1b)

And then with the project, I realised that with forms and reports I know much less than what I know about the rest of the stuff. (P3b)

As I finished each one, I highlighted it, and I knew, "OK, I did it. I'm fine. I can go to the next one." So, yes, and where I struggled, I made marks and asked in class, or I worked it out or asked someone. (P4b)

Participants P3b, P4b and P5b reported that they identified other resources for learning:

I asked like the people who were with us in class. Then how does it work? But theirs worked. But why doesn't mine work, as we did it exactly the same way? Then I realise my Access [the program installed on the computer] was actually the problem. (P3b)

I learnt the rules of normalisation and also used the Internet to see what others say about it. I watched YouTube videos of how people do ER diagrams. It was nice to see other scenarios all the time. (P5b)

All five participants mentioned that they applied SDL activities:

With the memorandums and stuff, it really helped me, because then you can see what one... and yes... and then I went and practised it again. (P1b)

I started [with the project] before the time, before we did normalisation, because I like to finish tasks. So I started in the holidays. (P2b)

When participant P3b was asked what she did when she realised that she did not know much about queries and reports, she replied that she took her textbook and studied how to do them, from the beginning.

Participant P2b gave conflicting reports on SDL. In the first instance, she mentioned that she enjoyed Access, because she enjoyed struggling with something and learning independently. She also mentioned that students have to pay attention in class and make good use of their time during the semester:

I enjoy Access, because I like it when I struggle to figure it out myself. If you pay attention in class and make good use of your time, the exam should just be revision. (P2b)

Participant P2b, however, did not apply the SDL activities that she reported on. She mentioned that she did not learn much for the test, because she would rather spend time on tasks that had to be submitted for marks. She thus only had time to study a day or so before the test. Furthermore, although participant P2b started early with the project and afterwards realised that her normalisation was not correct, she decided not to correct her mistakes. Only one other participant, P4b, made a comment that can also be linked to not being a self-directed learner. This comment was, however, made about the network part of the module:

They [computer networks] aren't something that interests me, and so I won't read up on networks in my own time or find more information on networks. (P4b)

5.1.2.3.3 Qualitative results related to the TLO tool after the second intervention of the first meso-cycle

The red dotted lines in Figure 5.9 are connected to themes that are associated with the categories of the TLO. Themes associated with low levels of the TLO categories are on the right-hand side in Figure 5.9. A strong theme that emerged from the data was that the participants were inclined to make connections ($G = 11$). Other themes that emerged were intrinsic motivation ($G = 6$) and extrinsic motivation ($G = 2$), good self-efficacy ($G = 6$) and low self-efficacy ($G = 3$), flexibility in learning ($G = 5$) and low flexibility in learning ($G = 1$), and learning independently ($G = 6$). These themes will now be elaborated on.

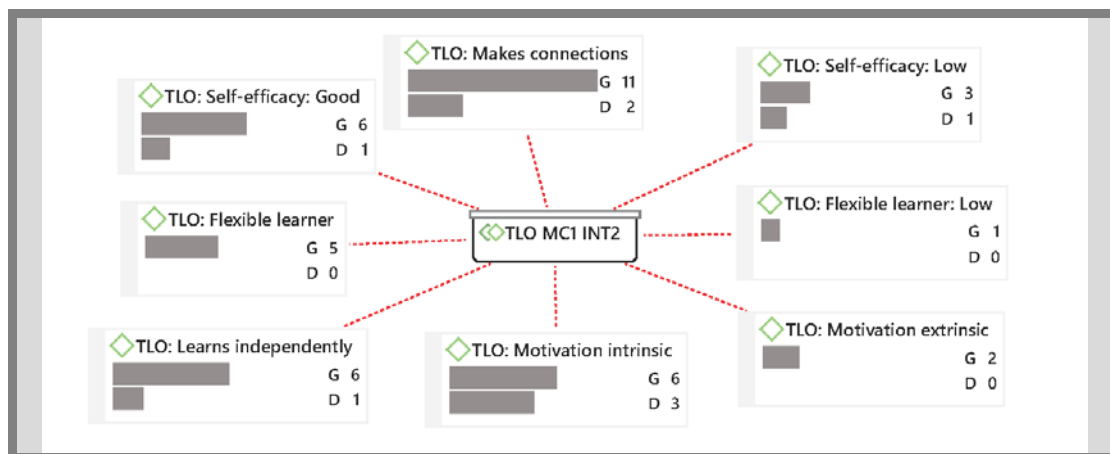


Figure 5.9: Qualitative results related to the TLO after the second intervention of the first meso-cycle

(a) Results for “self-efficacy”

Twice as many comments were linked to good self-efficacy (G = 6) as to low self-efficacy (G = 3). Participants mentioned that they enjoyed doing the project and the challenge that it posed. Participant P2b reported that it felt good to see the results of the project, which contributed towards her self-efficacy:

I never thought you'd be able to do your own database from table to report, and then even a menu, and your own pictures, and like you designed it yourself. So it's a nice feeling to think, “But OK, I can do it.” (P2b)

Participant P1b reported that although she battled to get the ER diagram right in the project, she persisted, and that she now knew what to do and what her mistakes were:

The ER diagram that I had to draw. Then I had one like this. Then I realised, “OK, but that's not right.” And then I tried this one again, and in the end he was still wrong. But I now have an idea of what to do. I know what was wrong. (P1b)

Participant P4b confirmed that after doing the project, she now found relationships much easier:

Yes, I must say now they're [relationships are] easier for me, especially after our project we did, because you had to do it all the time. (P4b)

Comments related to low self-efficacy were mostly related to the difficulty of the work. Participant P2b, for example, mentioned that because she did not like some questions on problem scenarios that had to be done in class, she found them difficult to do. Although participant P4b reported above that she understood relationships, she further reported that she still felt unsure about other activities. She persevered, however, and did what she could:

I must say all the time I was very uncertain. Everything I did in Forms was to me like I don't know if I'm right. Then I was like “Just create it. What's right will be right. Er, if you're struggling or whatever, just ask if you're unsure.” So I just went on. I always had a feeling of uncertainty, but I went through with it and did what I thought was good. Yes. (P4b)

(b) Results for “flexible learner”

As already indicated, the category of “flexible learner” in the TLO is associated with a learning belief of having control of the learning in the particular context (Simper *et al.*, 2016:1169). Comments of participants that indicated that they felt in control of their learning were thus associated with being flexible in learning. Most of these comments were related to the project that participants had to do:

It [the project] was nice. It was a challenge, and you could choose what it was about. So it was something that you're interested in. (P2b)

I started in the holiday [with the project]. I said I wasn't going to do it all in one day. I'm not going to mess it up. I'll do it bit by bit. (P4b)

Only one comment was linked to not being flexible in learning. Participant P2b reported on a difficult activity that they had to do in class. She mentioned that she was quite rigid in how she did things and in how she wanted questions to be formulated:

How should I know whether my word is right or whether that one should be left, and that one? No, I don't know how to figure it out. There's no formula. There isn't any, and I like it to be in black and white and bulleted, and this one isn't like that. I don't learn with pictures, diagrams, or mind maps, or any such things. (P2b)

(c) Results for “learns independently”

As indicated by Simper *et al.* (2016:1169), learning independently refers to participants that organise themselves and their learning to master content. Codes assigned to “learns independently” often overlapped with codes assigned to “SDL strategies and activities”:

[...] we first did them together, and then we did them on our own. So we tried to solve them together, and when I came to the hostel I tried to solve them on my own. (P1b)

When you pay attention in class and use your time wisely, the exam should just be revision. (P2b)

(d) Results for “makes connections”

Making connections emerged as a strong theme from the data (G = 11). All five participants indicated that they made connections with real-life scenarios and database concepts:

It was a “pool A” and a “pool B”, and we just looked at pool A, and they only played in pool A, so the various matches can take place in one pool and then a team, or many teams can also play in one pool. So the pool was just one-to-one all the time, and then... then it was played at different stadiums, and there can be different matches at different stadiums. That's how I understood it. (P1b)

And because rugby... We stay in South Africa. It's a big thing, and many girls watch it. Like I sit and watch it with my dad, or something like that. So that's... and you can compare it. You can just as well replace “rugby” with “netball”. It's going to be the same situation or scenario. (P2b)

(e) Results for “motivation”

Themes related to intrinsic and extrinsic motivation emerged from the data. Comments on enjoyment of learning were linked to intrinsic motivation ($G = 6$), while comments on tasks that participants did because they counted for marks were linked to extrinsic motivation ($G = 3$).

Participants P2b, P4b and P5b reported that they enjoyed Access and doing the project. These comments were linked to the theme of intrinsic motivation:

With the normalisation it was nice for me, those activities we got, those papers. And then we worked in groups of three or so. (P2b)

I never liked Access, and I'm now much more comfortable with it, so obviously I'm going to give more attention to my Access, because I like it more. I enjoy doing it more. I enjoy the challenge. (P4b)

Although participant P3b found the project challenging, she reported that it was good and a learning experience:

It [the project] was challenging. You had to go back to all the functions you learnt, because you forget some of them, and then apply them all again. So the project I think is cool if you want to implement it in future and you put a lot of effort into it. (P3b)

Participants P2b and P4b reported that doing assignments because they counted for marks was important for them. These comments were linked to extrinsic motivation:

[...] especially when I saw the allocated marks and realised, “But listen here. It [the project] counts 20% of my participation mark, so I really have to do well.” So there was a lot of pressure on me to perform well in it. (P4b)

5.1.3 Conclusion of discussion of the qualitative results of the first meso-cycle

In the above section the qualitative results of MC1 INT1 and MC1 INT2 were discussed. After discussing the results of MC1 INT1, it was indicated how the suggested guidelines were adjusted for MC1 INT2. For each intervention cycle, the factors that hindered transfer and participants' experiences of the implemented guidelines were discussed. Qualitative results related to SDL, the categories of the TLO, and CL as a teaching-learning strategy were also reported on. In the following section, the quantitative results of MC1 will be reported on.

5.1.4 Reporting on the quantitative results of the first meso-cycle

The SRSSDL and the TLO questionnaires (see section 4.4.1.2) were completed by willing participants as pre-tests at the start of MC1 and as post-tests at the end of MC1 (see Figure 4.5). In this section, the results of these questionnaires will be reported on. The pre-test and post-test results of the SRSSDL will be discussed first, followed by the pre-test and post-test results of the TLO.

5.1.4.1 Results of the Self-Rating Scale of Self-Directed Learning in the first meso-cycle

The reliability of the SRSSDL was confirmed by determining the Cronbach's alpha coefficients of each category measured by the SRSSDL. All questions from each category of the SRSSDL, as indicated by Williamson (2007:75), were used each time when calculating the descriptive and the inferential statistics.

Twenty-one participants completed the pre-SRSSDL (N = 21), and 20 participants completed the post-SRSSDL (N = 20). The demographics of the participants are indicated in Table 5.3. The number of male and female participants and the number of participants in the age groups of 20 years, 21 years, and 22 years or older are indicated. Participants could either be enrolled for the Intermediate and Senior Phase (Int/Snr) or the Senior and Further Education and Training Phase (Snr/FET) programmes in education. If registered for the Int/Snr programme, participants would be qualified to teach learners in grades 4 to 9 in South African schools once they completed their studies. Participants registered for the Snr/FET programme would be allowed to teach learners in grades 8 to 12 in South African schools on successful completion of their studies.

Students would usually enrol for the database module implicated in this research in their third year of study, but with the pre-SRSSDL and the post-SRSSDL five participants were each time in the fourth year of their studies. This meant that they had either failed this module once or they had changed the subject area that they were studying in, and thus still had to complete this module in their fourth year. The number of participants that expected to obtain a certain final percentage for this module was also determined. In the post-SRSSDL, more participants expected to obtain a percentage in the ranges of 51% to 60% and 61% to 70%. In the pre-SRSSDL, 12 participants expected to obtain a percentage of 71% to 80%, but in the post-SRSSDL only five participants expected percentages in that range.

Table 5.3: Demographics of the participants in the pre-SRSSDL and the post-SRSSDL in the first meso-cycle

Pre-SRSSDL (N = 21)				Post-SRSSDL (N = 20)			
Male	Female	Int/Snr	Snr/FET	Male	Female	Int/Snr	Snr/FET
3	18	9	12	2	18	8	12
Third-year students		Fourth-year students		Third-year students		Fourth-year students	
16		5		15		5	
Age 20 years	Age 21 years	Age ≥ 22 years		Age 20 years	Age 21 years	Age ≥ 22 years	
4	11	6		2	11	7	
Expected %	≤ 40%	41%–50%	51%–60%	61%–70%	71%–80%	≥ 81%	
Pre-SRSSDL	1	0	3	2	12	3	
Post-SRSSDL	0	0	6	7	5	2	

Table 5.4 shows the descriptive statistics for the pre-SRSSDL and the post-SRSSDL.

Table 5.4: Descriptive statistics for the pre-SRSSDL and the post-SRSSDL in the first meso-cycle

SRSSDL category	Pre-SRSSDL (N = 21)				Post-SRSSDL (N = 20)			
	Minimum	Maximum	Mean	SD	Minimum	Maximum	Mean	SD
Awareness	3.50	4.67	4.0159	0.33708	3.33	4.58	3.9792	0.36462
Learning strategies	2.75	4.75	3.6270	0.52016	2.50	4.83	3.6500	0.53298
Learning activities	3.00	4.67	3.8016	0.40950	2.75	4.75	3.8625	0.45102
Evaluation	3.00	4.50	3.9008	0.36479	3.00	4.67	3.8208	0.39019
Interpersonal skills	2.83	5.00	3.9524	0.50729	2.75	4.75	3.9417	0.48448
Total score	187.00	276.00	231.5714	20.68229	185.00	281.00	231.0500	22.24144

Twenty participants completed both the pre-SRSSDL and the post-SRSSDL. The descriptive statistics are indicated in Table 5.5 below. In the remainder of this discussion, only statistical results of participants that completed both the pre-SRSSDL and the post-SRSSDL (N = 20) will be reported on.

Table 5.5: Paired-samples statistics for the pre-SRSSDL and the post-SRSSDL in the first meso-cycle

Category	N	Pre-SRSSDL	Post-SRSSDL	Mean difference (post – pre)	Effect size	p-value
Awareness	20	3.98750	3.97917	-0.0083	0.03	0.926
Learning strategies	20	3.58333	3.65000	0.0667	0.14	0.318
Learning activities	20	3.79166	3.86250	0.0708	0.17	0.312
Evaluation	20	3.90833	3.82083	-0.0875	0.23	0.194
Interpersonal skills	20	3.96250	3.94167	-0.0208	0.04	0.781
Total score	20	230.8	231.05	0.2500	0.01	0.941

Effect size: *0.2 < |d| ≤ 0.5 **|d| > 0.8 p-value: *p < 0.1

When viewing the results of participants that completed both the pre-SRSSDL and the post-SRSSDL, a small improvement is noted in the scores for “learning strategies” and “learning activities” and in the total score. However, no notable effect sizes are noticed.

To obtain more insight into the results, the SRSSDL scores of participants were categorised according to moderate and high SDL levels. According to Williamson (2007:72), scores can be divided into low (total SDL score ≥ 60 and ≤ 140), moderate (total SDL score ≥ 141 and ≤ 220) and high (total SDL score ≥ 221 and ≤ 300) levels of SDL. No scores, according to the results of the pre-SRSSDL and the post-SRSSDL, fell in the low SDL group. In the pre-SRSSDL the SDL scores of eight participants were in the moderate SDL group, and the scores of 12 participants

were in the high SDL group. In the post-SRSSDL, the scores of four participants were in the moderate group, and the scores of 16 participants were in the high SDL category. Four participants thus moved from the moderate SDL group to the high SDL group in the post-SRSSDL. The movement of participants from the moderate SDL group to the high SDL group is depicted in Figure 5.10.

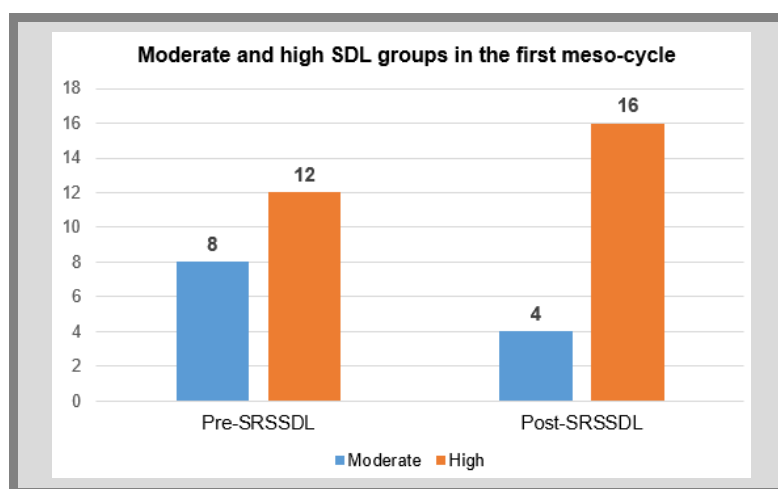


Figure 5.10: Moderate and high SDL groups in the first meso-cycle

In the following section, the statistical results of the pre-SRSSDL and the post-SRSSDL will be reported on according to the moderate and the high SDL groups.

Table 5.6 shows the paired-samples statistics calculated for each category of the SRSSDL for the moderate and the high SDL groups. In the moderate SDL group, the mean value of the learning strategies category improved with a small effect ($d = 0.28$). The mean value of the learning activities category improved with a medium effect ($d = 0.49$). The mean value of the interpersonal skills category also improved ($d = 0.02$), but with no notable effect size, and the total SDL score improved with a small effect ($d = 0.22$).

The high SDL group showed an improvement in the learning strategies ($d = 0.16$) and the learning activities categories ($d = 0.08$), but with no notable effect sizes. The mean scores in all other categories, as well as the total SDL mean score, decreased, where the decrease in the evaluation category had a medium effect ($d = 0.51$).

Table 5.6: Paired-samples statistics for the moderate and the high SDL groups in the first meso-cycle

SRSSDL category	Moderate SDL (N = 8)				High SDL (N = 12)			
	Mean	Mean difference	Effect size	p-value	Mean	Mean difference	Effect size	p-value
Awareness (pre)	3.8646	-0.0104	0.03	0.952	4.0694	-0.0069	0.03	0.948
Awareness (post)	3.8542				4.0625			
Learning strategies (pre)	3.1458	0.0729	0.28	0.582	3.8750	0.0620	0.16	0.412
Learning strategies (post)	3.2188				3.9375			
Learning activities (pre)	3.4167	0.1458	*0.49	0.239	4.0416	0.0203	0.08	0.813
Learning activities (post)	3.5625				4.0625			
Evaluation (pre)	3.5938	-0.0104	0.04	0.925	4.1181	-0.1389	*0.51	0.117
Evaluation (post)	3.5833				3.9792			
Interpersonal skills (pre)	3.5937	0.0104	0.02	0.938	4.2083	-0.0417	0.11	0.661
Interpersonal skills (post)	3.6041				4.1667			
Total SDL score (pre)	211.375	2.5000	0.22	0.712	243.750	-1.2500	0.08	0.746
Total SDL score (post)	213.875				242.500			

*Effect size medium: $0.2 < |d| \leq 0.5$

**Effect size large: $|d| > 0.8$

p-value: * $p < 0.1$

Because of the small number of participants ($N = 20$), the results of the pre-SRSSDL and the post-SRSSDL will also be analysed for each participant, so as to obtain more insight into the results. Table 5.7 shows the individual scores for each participant in the various SDL categories. The scores of participants P1 to P4 were in the moderate SDL category after the post-SRSSDL. It should be noted that the numbering of participants ("P1", "P2", etc.) is not according to the numbering that was used when the qualitative results were reported on. Not all participants that took part in interviews completed the pre-SRSSDL and the post-SRSSDL. Participants could therefore not be numbered consistently during the qualitative and the quantitative data collection. Table 5.7 also indicates the number of mean scores for the various categories of the SRSSDL, as well as the total SDL scores that increased (No. +), decreased (No. -) or stayed the same (Same).

Table 5.7: Pre-SRSSDL and post-SRSSDL scores for each participant in the first meso-cycle

Participant	Awareness			Learning strategies			Learning activities			Evaluation			Interpersonal skills			Total SDL		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
P1	3.5	3.4	-0.1	3.1	3.2	0.1	3.2	3.1	-0.1	3.0	3.0	0.0	2.8	2.8	-0.1	187	185	-2
P2	4.7	3.9	-0.8	3.2	2.5	-0.7	3.0	2.8	-0.3	3.4	3.1	-0.3	4.0	3.5	-0.5	219	189	-30
P3	4.0	3.4	-0.6	3.5	3.7	0.2	3.8	3.8	-0.1	3.8	3.2	-0.6	3.2	3.0	-0.2	219	204	-15
P4	3.8	3.9	0.1	2.8	2.8	0.0	3.3	3.4	0.2	3.7	3.8	0.1	3.6	3.7	0.1	206	211	5
P5	3.7	3.6	-0.1	3.2	3.1	-0.1	3.6	3.9	0.3	3.7	3.9	0.3	4.3	3.9	-0.3	220	221	1
P6	3.6	3.3	-0.3	3.6	3.5	-0.1	3.7	3.8	0.1	3.8	3.6	-0.3	5.0	4.5	-0.5	236	224	-12
P7	3.7	4.2	0.5	3.3	3.4	0.2	3.5	3.8	0.3	3.8	3.8	0.0	3.3	3.8	0.4	210	227	17
P8	3.9	3.8	-0.2	4.0	3.8	-0.3	4.1	3.4	-0.7	4.5	3.8	-0.7	4.5	4.5	0.0	252	231	-21
P9	4.0	3.7	-0.3	3.5	3.6	0.1	4.1	4.3	0.2	4.3	4.2	-0.1	3.9	3.8	-0.1	237	234	-3
P10	3.8	4.2	0.3	2.8	3.3	0.5	3.3	4.0	0.8	3.8	4.0	0.3	4.0	4.1	0.1	211	234	23
P11	3.8	4.1	0.3	3.3	3.6	0.3	3.8	3.9	0.2	3.8	3.9	0.1	3.8	4.1	0.3	221	235	14
P12	4.3	4.1	-0.3	3.8	3.8	-0.1	4.3	4.1	-0.3	4.2	3.8	-0.3	4.2	3.9	-0.3	250	236	-14
P13	4.4	3.8	-0.6	4.2	3.9	-0.3	4.2	4.0	-0.2	4.3	3.9	-0.4	4.3	4.1	-0.3	257	237	-20
P14	4.0	4.3	0.3	3.7	4.3	0.6	3.8	3.8	0.0	3.9	3.8	-0.1	4.3	3.7	-0.6	236	238	2
P15	3.9	4.3	0.3	3.8	3.7	-0.2	3.9	3.9	0.0	4.1	3.8	-0.3	3.7	4.2	0.5	233	238	5
P16	3.8	4.3	0.5	3.4	3.8	0.4	3.8	3.8	0.0	3.8	4.0	0.3	3.6	4.2	0.6	219	240	21
P17	4.2	4.0	-0.2	4.0	4.1	0.1	4.1	4.2	0.1	3.7	4.1	0.4	4.1	4.0	-0.1	240	244	4
P18	3.8	4.6	0.8	3.8	4.2	0.3	3.8	4.4	0.6	4.0	3.8	-0.2	3.8	4.0	0.2	232	252	20
P19	4.4	4.5	0.1	4.1	4.2	0.1	4.1	4.3	0.2	4.3	4.3	-0.1	4.3	4.5	0.2	255	260	5
P20	4.4	4.4	0.0	4.8	4.8	0.1	4.7	4.8	0.1	4.5	4.7	0.2	4.7	4.8	0.1	276	281	5
No. +	9			12			11			7			9			12		
No. -	10			7			6			11			10			8		
Same	1			1			3			2			1			0		

Figure 5.11 depicts the mean scores for each participant for each category of the SRSSDL and the total SDL scores, as summarised in Table 5.7. The movement in scores from the pre-SRSSDL to the post-SRSSDL for each category is thus depicted in Figure 5.11.

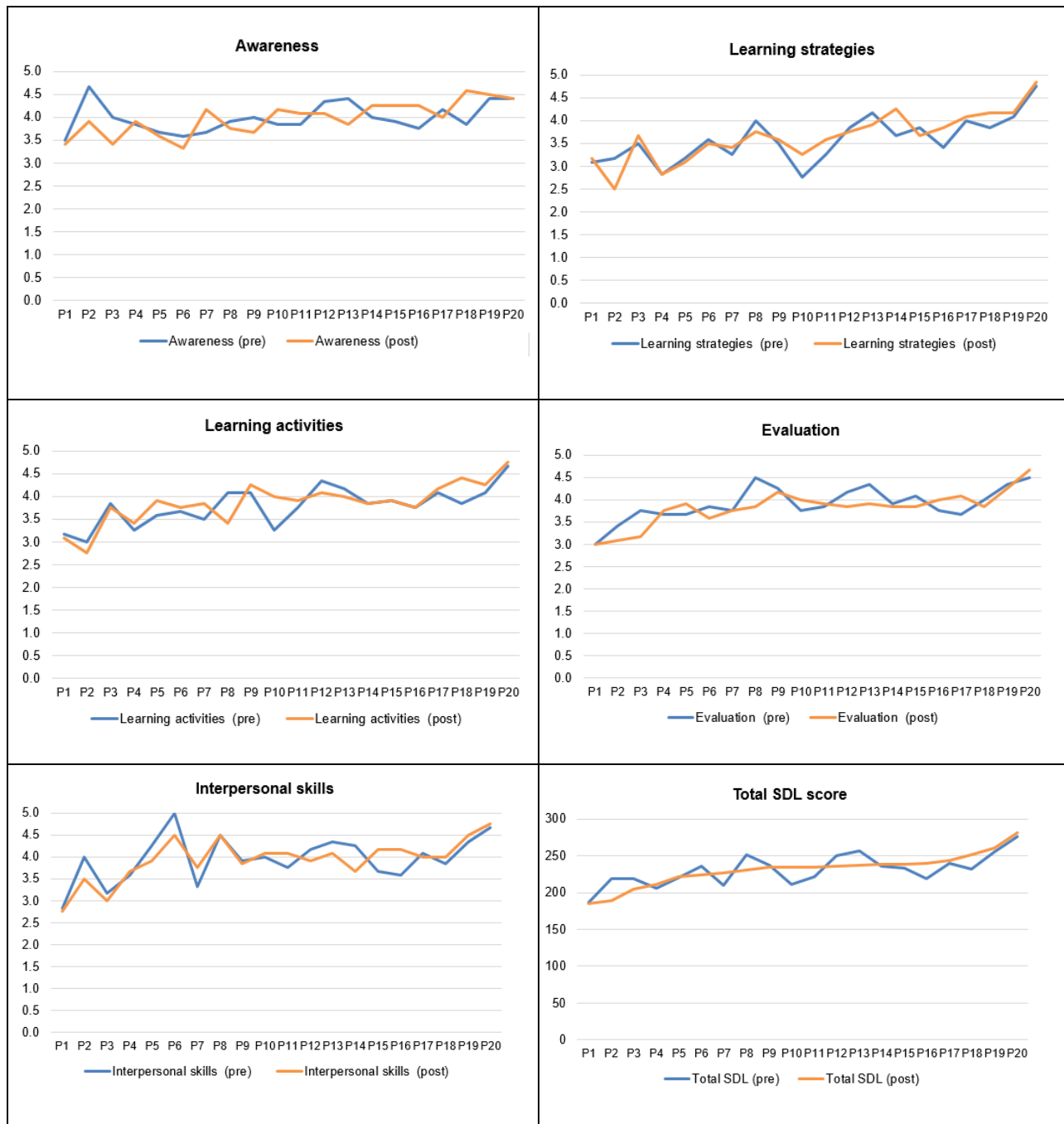


Figure 5.11: Movement in SDL scores for each category in the first meso-cycle

In the following section the results of the TLO questionnaire in the first meso-cycle will be reported on.

5.1.4.2 Results of the pre-TLO and the post-TLO tool in the first meso-cycle

At the start of MC1, along with the SRSSDL, the TLO (see section 4.4.1.2) was administered as a pre-test (see Figure 4.5) to willing participants. The post-TLO was completed by willing participants after the second intervention of MC1.

When the reliability of the TLO questionnaire was determined, it was found that the Cronbach's alpha indicated poor reliability ($\alpha = 0.220$) on the outcome motivation category. After omitting questions 2, 4 and 5 from the statistical analysis, the Cronbach's alpha yielded an acceptable reliability of 0.524. Therefore, only questions 1 and 3 were used when calculating the descriptive and the inferential statistics for the category "outcome motivation". The flexible learner category indicated a low reliability ($\alpha = 0.300$) and after removing question 9, the reliability improved ($\alpha = 0.553$). The transfer category also initially indicated a low reliability ($\alpha = 0.438$). After omitting question 22 from the transfer category, the reliability increased to an acceptable level of 0.571. All other categories of the TLO indicated acceptable reliability. Table 5.8 provides a summary of the reliability of the various categories of the TLO, as well as the questions that were included and omitted when calculating the descriptive and the inferential statistics. As indicated by Simper *et al.* (2016:1169), more user-friendly terms can also be used for the categories of the TLO (see section 4.4.1.2.2 and Table 4.6), and therefore both terms for each category are given in Table 5.8.

Table 5.8: Reliability of the TLO in the first meso-cycle

Category	Cronbach's alpha (α)	Questions included	Questions omitted
Self-motivated / outcome motivation	0.524	Q1, Q3	Q2, Q4, Q5
Flexible learner / learning belief	0.553	Q6, Q7, Q8, Q11	Q9
Confident / self-efficacy	0.892	Q12(r), Q13, Q14, Q15, Q17	
Makes connections / transfer	0.571	Q18, Q19, Q20	Q22
Learns independently / organisation	0.607	Q23, Q24, Q25(r), Q26, Q28	

When completing the TLO questionnaire, participants could rate themselves on a scale of 1 to 5. It was assumed that participants would have at least some qualities in each of the categories, and therefore the bottom value of the scale was given as 1. When analysing the responses, the scales of the questions were adjusted to range from 0 to 4, to align with the rubric-type questions in the questionnaire, which consisted of only four options, coded as 1 to 4.

5.1.4.2.1 Descriptive statistics of the pre-TLO and the post-TLO tool in the first meso-cycle

Twenty-one participants ($N = 21$) completed the post-TLO in the first meso-cycle. Seventeen participants ($N = 17$) completed both the pre-TLO and the post-TLO. Only the results of participants that completed both the pre-TLO and the post-TLO ($N = 17$) will be reported on in the remainder of this discussion.

Table 5.9 shows the results of the paired-samples statistics of the pre-TLO and the post-TLO. The mean value of the category "self-motivated" decreased, but with no notable effect size ($d = 0.12$). The mean value of the category "flexible learner" decreased with a medium effect ($d =$

0.35). The mean value of the “confident” category, however, decreased with a large effect ($d = 0.54$). Table 5.9 further indicates an increase in the mean values of the “makes connections” ($d = 0.26$) and the “learns independently” ($d = 0.22$) categories, both with a medium effect.

Table 5.9: Paired-samples statistics of the TLO in the first meso-cycle

Category	N	Mean pre-TLO	Mean post-TLO	Mean difference (post – pre)	Effect size (d)	p -value
Self-motivated	17	1.8824	1.7647	-0.1177	0.12	0.571
Flexible learner	17	3.0588	2.8823	-0.1765	0.35*	0.168
Confident	17	3.1529	2.8118	-0.3411	0.54**	0.021*
Makes connections	17	2.6275	2.7843	0.1568	0.26*	0.375
Learns independently	17	2.6000	2.7176	0.1176	0.22*	0.440

*Effect size medium: $0.2 < |d| \leq 0.5$ **Effect size large: $|d| > 0.8$ p -value: * $p < 0.1$

In Figure 5.12, the decrease in the mean scores of the first three categories, as well as the increase in the “makes connections” and the “learns independently” categories, can be observed.

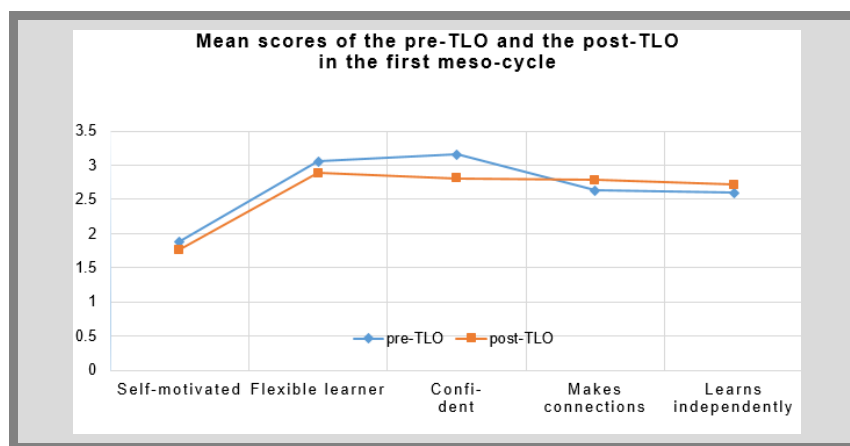


Figure 5.12: Mean scores of the pre-TLO and the post-TLO in the first meso-cycle

To obtain more insight into the mean scores, the scores for each participant for each category of the pre-TLO and the post-TLO will be reported on next. Table 5.10 indicates the individual mean scores for each participant for each category. The numbering of participants does not agree with the numbering of participants in the SRSSDL (see Table 5.7), because not all participants completed both the SRSSDL and the TLO pre-tests and post-tests.

When comparing the mean scores of individual participants for each category, it is evident that some participants improved on their score in the categories. In each category, the average score of each participant is indicated for the pre-TLO and the post-TLO. Table 5.10 further indicates the difference between the average scores of the pre-TLO and the post-TLO. The total number of average scores that improved is indicated below the table. “No. +” indicates the total

number of mean scores in the category that improved, while “No. –” indicates the total number of mean scores in the category that decreased. The total number of mean scores in each category that stayed the same is also indicated.

According to Table 5.10, the categories where more participants improved their scores were “makes connections” (No. + = 7) and “learns independently” (No. + = 9). In the “confident” (No. – = 11) and “flexible learner” (No. – = 9) categories, more scores decreased. The number of scores that increased in the “self-motivated” category (No. + = 7) was only one participant less than the number of scores that decreased (No. – = 8).

Table 5.10: Individual mean scores for each participant for each category of the pre-TLO and the post-TLO in the first meso-cycle

Participant	Self-motivated			Flexible learner			Confident			Makes connections			Learns independently		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
P1	1.00	2.00	1.00	2.80	2.80	0.00	2.60	3.00	0.40	3.00	3.67	0.67	2.80	2.80	0.00
P2	3.00	1.50	-1.50	2.00	2.40	0.40	1.60	2.20	0.60	1.67	3.67	2.00	1.80	1.00	-0.80
P3	1.50	1.50	0.00	3.20	3.00	-0.20	3.00	3.00	0.00	3.33	3.00	-0.33	2.60	2.60	0.00
P4	1.00	2.00	1.00	2.80	3.20	0.40	3.00	2.80	-0.20	2.33	2.33	0.00	2.80	3.20	0.40
P5	4.00	2.50	-1.50	3.80	3.80	0.00	3.60	3.00	-0.60	1.67	2.33	0.67	2.80	2.20	-0.60
P6	3.00	3.50	0.50	3.00	3.00	0.00	3.00	2.20	-0.80	2.00	2.33	0.33	2.40	3.40	1.00
P7	3.00	2.00	-1.00	3.40	3.00	-0.40	3.40	3.40	0.00	2.67	2.67	0.00	3.20	3.40	0.20
P8	2.00	2.00	0.00	2.40	2.60	0.20	2.00	1.80	-0.20	2.33	2.33	0.00	1.40	1.80	0.40
P9	1.50	1.00	-0.50	3.60	2.60	-1.00	3.60	2.40	-1.20	2.67	2.33	-0.33	2.40	3.60	1.20
P10	2.50	1.50	-1.00	2.40	2.80	0.40	3.40	3.00	-0.40	2.67	2.67	0.00	3.40	2.40	-1.00
P11	1.00	1.50	0.50	3.00	2.80	-0.20	2.80	2.40	-0.40	2.00	2.00	0.00	2.40	2.40	0.00
P12	2.00	1.50	-0.50	3.00	2.20	-0.80	3.60	2.00	-1.60	4.00	2.67	-1.33	3.00	2.40	-0.60
P13	2.00	1.50	-0.50	3.00	3.60	0.60	3.20	3.40	0.20	3.00	3.00	0.00	2.80	3.00	0.20
P14	2.00	1.50	-0.50	3.80	2.80	-1.00	3.60	3.00	-0.60	3.00	2.33	-0.67	2.40	3.20	0.80
P15	0.50	1.50	1.00	3.60	3.20	-0.40	4.00	4.00	0.00	3.00	3.67	0.67	3.20	3.40	0.20
P16	1.50	2.00	0.50	2.80	2.00	-0.80	3.40	2.80	-0.60	2.33	2.67	0.33	1.80	2.40	0.60
P17	0.50	1.00	0.50	3.40	3.20	-0.20	3.80	3.40	-0.40	3.00	3.67	0.67	3.00	3.00	0.00
	No. –		8	No. –		9	No. –		11	No. –		4	No. –		4
	No. +		7	No. +		5	No. +		3	No. +		7	No. +		9
	Same		2	Same		3	Same		3	Same		6	Same		4

The movement in the average scores for each category of the TLO, as summarised above in Table 5.10, is depicted in Figure 5.13. In the “confident” category, it is evident that the scores of most of the participants dropped in the post-TLO. In the other categories, some participants improved their scores, with more improvements noticed in the “makes connections” and the “learns independently” categories.



Figure 5.13: Individual mean scores for each participant for each category of the TLO in the first meso-cycle

In the next section, spider diagrams drawn from the TLO results in MC1 will be discussed.

5.1.4.2.2 Spider diagrams drawn from the TLO results in the first meso-cycle

As suggested by Simper *et al.* (2016:1172), spider diagrams (see Table 5.12) indicating the mean score for each participant for each category were drawn from the pre-TLO and the post-TLO results. The mean scores could range between 0 and 4.

With each spider diagram, the number of the participant corresponding to Table 5.10 and the percentages obtained in the two transfer tests (see section 4.4.1.1) are indicated. “TT1” refers to the transfer test written after the first intervention, and “TT2” refers to the transfer test written after the second intervention. Quotes obtained from the open-ended questions of the TLO relevant to each category are also provided in Table 5.12, to clarify the reasoning of the

participant when they gave the self-assessment scores for each category. To provide clarity on the open-ended questions, the questions for each category are indicated in Table 5.11.

Table 5.11: Open-ended questions for each category of the TLO

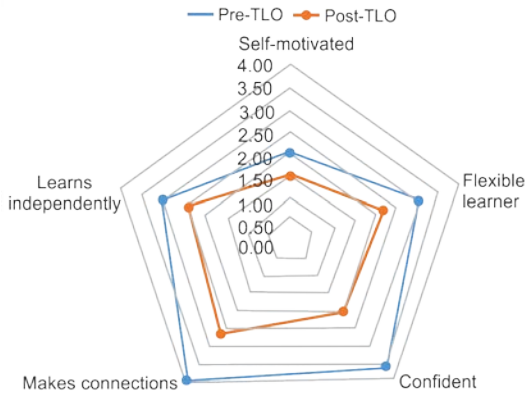
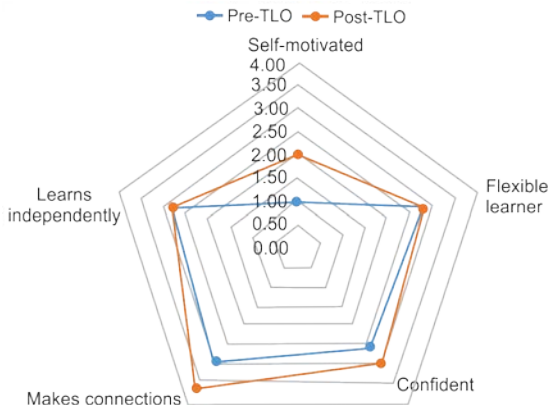
Category	Question
Self-motivated / outcome motivation	What is it that personally motivates you in this course?
Flexible learner / learning belief	Reflecting on the way you apply yourself, what control do you believe you had over “factors” that affected your academic achievement?
Confident / self-efficacy	Describe any areas of the course that you lack confidence in tackling.
Makes connections / transfer	How did you apply cognitive strategies (perceiving, thinking, and remembering) this year?
Learns independently / organisation	Describe how you organised your work process for this course.
All questions listed in the table are obtained from the TLO (Simper <i>et al.</i> , 2016).	

The shape of each spider diagram reflects the weak and the strong areas as self-assessed by the participant (Simper *et al.*, 2016:1170). In Table 5.12, participant P2 thus indicated being self-motivated as a strong characteristic in the pre-TLO. In the post-TLO, however, the participant indicated making connections as her strongest characteristic. Improvements are also noted in all other categories, except in the categories “self-motivated” and “learns independently”. Table 5.12 further indicates that the percentage obtained in the transfer test by participant P2 improved from 38% to 47%.

Table 5.12: Spider diagrams from the pre-TLO and the post-TLO results in the first meso-cycle

Participant P2: TT1 = 38%; TT2 = 47%	
Legend: Pre-TLO (blue), Post-TLO (orange) Dimensions: Self-motivated, Flexible learner, Confident, Makes connections, Learns independently	Confident / self-efficacy: <i>The difficulty of creating tables, forms, queries, and reports. (pre)</i> <i>Networks in capital letters. (post)</i>
	Makes connections / transfer: <i>Problem-solving is relevant to this module. (pre)</i> <i>The practising of skills broadened knowledge. (post)</i>
	Learns independently: <i>Plan in diary and group session. (pre)</i> <i>Each Wednesday, a friend and I worked on the preparation and class activities. (post)</i>
Self-motivated: <i>I am a final-year student and need to catch up with this module. (pre)</i> <i>I didn't have CAT at school; I have no background. (post)</i>	Flexible learner / learning belief: <i>The fact that we need to be self-directed. (pre)</i> <i>I came to realise that I have to get more resources. (post)</i>
Participant P17: TT1 = 94%; TT2 = 57%	
Legend: Pre-TLO (blue), Post-TLO (orange) Dimensions: Self-motivated, Flexible learner, Confident, Makes connections, Learns independently	Confident / self-efficacy: <i>New work is better learnt by having guidance. (pre)</i> <i>I will have to spend a lot of time on networks. (post)</i>
	Makes connections / transfer: <i>Prepare, work through textbook, remember, and repeat. (pre)</i> <i>Problem-solving took place when I solved with fellow students. (post)</i>
	Learns independently: <i>I plan my time. I do all preparation in the weekend. In class I make notes. (pre)</i> <i>I plan for all assignments, tests, to determine what I should do when. (post)</i>
Self-motivation: <i>To use the software in full. By proving to myself I am capable of certain marks. (pre)</i> <i>Get a good job. (post)</i>	Flexible learner / learning belief: <i>Time management, be curious, motivation to obtain a distinction. (pre)</i> <i>I am organised. I have a fixed way of learning for a specific subject. (post)</i>

Table 5.12: Spider diagrams from the pre-TLO and the post-TLO results in the first meso-cycle (cont.)

Participant P12; TT1 = 76%; TT2 = 65%	
 Pre-TLO Post-TLO Self-motivated 4.00 3.50 3.00 2.50 2.00 1.50 1.00 0.50 0.00 Learns independently Flexible learner Confident Makes connections	Confident / self-efficacy: Access is a difficult program to understand. (pre) Access is a huge challenge. (post)
	Makes connections / transfer: Problem-solving, think, and remember. Only learn and practise. (pre) Solving problems. (post)
	Learns independently: Organise time and use good resources. (pre) Set aims and manage time effectively. (post)
Self-motivation: The practical skills that I am accumulating. (pre) To solve a problem on Access with a fellow student. (post)	Flexible learner / learning belief: I managed my time well and I worked hard in this module. I must make sure I perform well. (pre) Managing time is important. (post)
Participant P1: TT1 = 30%; TT2 = 68%	
 Pre-TLO Post-TLO Self-motivated 4.00 3.50 3.00 2.50 2.00 1.50 1.00 0.50 0.00 Learns independently Flexible learner Confident Makes connections	Confident / self-efficacy: Relationships are a challenge. Networks, concepts are difficult to understand. (pre) Some tasks in Access are still difficult. (post)
	Makes connections / transfer: By repetition. It's important for me to repeat work in order to understand it. (pre) I made use of repetition a lot and prepared, and some concepts I did again and again and practised. (post)
	Learns independently: I try to do my weekly preparation as soon as possible, to focus on class preparation. (pre) I prepared for class, repeated concepts after class, and practised. (post)
Self-motivation: To understand the content and be academically successful and give my best. (pre) The content of the module is interesting. I enjoy learning new concepts. (post)	Flexible learner / learning belief: Other factors have a big influence. New knowledge has to be gained in a short time. (pre) The approach was often difficult. I didn't always know how to learn. Access required a lot of practice. (post)

In the following section, the results of the TLO will be compared with the results of the SRSSDL.

5.1.4.3 Results of the TLO tool compared with results of the SRSSDL in the first meso-cycle

The results of the pre-TLO and the post-TLO and the results of the pre-SRSSDL and the post-SRSSDL were compared with each other. The comparison of the results will be reported on in

this section. The results of the SRSSDL were split into the moderate SDL group and the high SDL group, to determine how participants in each group scored on the TLO (see Table 5.13). A paired-samples test was then done to statistically compare the means of the various categories in the moderate and the high SDL groups.

Seventeen participants completed both the pre-TLO and the pre-SRSSDL ($N = 17$). Table 5.13 indicates the differences in the mean scores of the various categories between the pre-TLO and the post-TLO in the moderate and the high SDL groups. In the moderate SDL group, the decrease in the mean of the “confident” category indicates a large effect ($d = 1.93$). In the same group, the means of the TLO categories “flexible learner” ($d = 0.72$) and “makes connections” ($d = 0.39$) decreased, with a medium-sized effect.

Table 5.13: Paired-samples statistics for the TLO for the moderate and the high SDL groups in the first meso-cycle

SDL group	TLO category	Mean pre-TLO	Mean post-TLO	Mean difference	Effect size	<i>p</i> -value
Moderate SDL ($N = 6$)	Self-motivated	1.67	1.67	0.00	0.00	1.000
	Flexible learner	2.97	2.63	-0.33	0.72*	0.250
	Confident	3.30	2.67	-0.63	1.93**	0.026
	Makes connections	2.72	2.44	-0.28	0.39*	0.317
	Learns independently	2.63	2.67	0.03	0.06	0.913
High SDL ($N = 11$)	Self-motivated	2.00	1.82	-0.18	0.16	0.519
	Flexible learner	3.11	3.02	-0.09	0.17	0.501
	Confident	3.07	2.89	-0.18	0.24*	0.284
	Makes connections	2.58	2.97	0.39	0.68*	0.077
	Learns independently	2.58	2.75	0.16	0.29*	0.376

*Effect size medium: $0.2 < |d| \leq 0.5$ **Effect size large: $|d| > 0.8$ *p*-value: $*p < 0.1$

In the high SDL group, the mean of the TLO category “makes connections” improved with a medium-sized effect ($d = 0.68$). The mean of the category “learns independently” improved with a small effect ($d = 0.29$). In the “confident” category a decrease in the mean with a small effect ($d = 0.24$) is observed.

A Spearman’s rho correlation was also done on results of the TLO and the SRSSDL (see Table 5.14). A comparison of the results of the pre-TLO and the pre-SRSSDL will first be given, followed by a comparison of the results of the post-TLO and the post-SRSSDL.

Table 5.14: Correlations between categories of the pre-TLO and the pre-SRSSDL in the first meso-cycle

Pre-TLO categories	N = 17	Pre-SRSSDL categories					
		Awareness	Learning strategies	Learning activities	Evaluation	Inter-personal skills	Total SDL
Self-motivated	Correlation coefficient	0.258	0.066	0.045	-0.233	0.042	0.137
	Sig. (2-tailed)	0.318	0.801	0.863	0.368	0.872	0.600
Flexible learner	Correlation coefficient	0.413	0.304	0.341	0.062	-0.185	0.204
	Sig. (2-tailed)	0.099	0.235	0.181	0.813	0.477	0.433
Confident	Correlation coefficient	0.565*	0.121	0.210	-0.097	-0.129	0.113
	Sig. (2-tailed)	0.018	0.642	0.418	0.712	0.621	0.666
Makes connections	Correlation coefficient	0.173	-0.117	-0.049	0.033	-0.052	-0.173
	Sig. (2-tailed)	0.507	0.656	0.853	0.900	0.843	0.507
Learns independently	Correlation coefficient	0.707**	0.194	0.178	-0.215	-0.233	0.055
	Sig. (2-tailed)	0.002	0.455	0.494	0.408	0.368	0.834

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

Correlations between some categories of the pre-TLO and the pre-SRSSDL (see Table 5.14) were noticed. Mertler (2016:277), however, argues that correlation between categories “does not imply causation”, and further investigation of these correlations is thus required. The “confident” ($r_s = 0.565$) and the “learns independently” ($r_s = 0.707$) categories of the pre-TLO correlate with the “awareness” category of the pre-SRSSDL.

Correlations between the post-TLO and the post-SRSSDL are indicated in Table 5.15. The post-TLO and the post-SRSSDL did not correlate on the same categories as the pre-TLO and the pre-SRSSDL. Twenty participants completed both the post-TLO and the post-SRSSDL (N = 20). The “confident” category of the post-TLO correlates with the “awareness” ($r_s = 0.613$) and the “learning activities” ($r_s = 0.469$) categories and the total score of the post-SRSSDL ($r_s = 0.486$). The “learns independently” category of the post-TLO correlates with the “awareness” ($r_s = 0.526$), the “learning activities” ($r_s = 0.565$) and the “evaluation” ($r_s = 0.481$) categories of the post-SRSSDL.

Table 5.15: Correlations between the categories of the post-TLO and the post-SRSSL in the first meso-cycle

Post-TLO categories	N = 20	Post-SRSSL categories					
		Awareness	Learning strategies	Learning activities	Evaluation	Inter-personal	Total SSL
Self-motivated	Correlation coefficient	-0.399	-0.100	0.144	0.054	-0.166	-0.140
	Sig. (2-tailed)	0.081	0.675	0.544	0.823	0.485	0.556
Flexible learner	Correlation coefficient	0.423	0.205	0.298	0.227	0.027	0.354
	Sig. (2-tailed)	0.063	0.385	0.202	0.336	0.910	0.126
Confident	Correlation coefficient	0.613**	0.301	0.469*	0.398	0.096	0.486*
	Sig. (2-tailed)	0.004	0.197	0.037	0.082	0.686	0.030
Makes connections	Correlation coefficient	0.324	0.388	0.289	0.117	0.127	0.304
	Sig. (2-tailed)	0.163	0.091	0.217	0.624	0.593	0.192
Learns independently	Correlation coefficient	0.526*	0.139	0.565**	0.481*	0.088	0.434
	Sig. (2-tailed)	0.017	0.558	0.009	0.032	0.711	0.056

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).

5.1.4.4 Conclusion of discussion of the quantitative results of the first meso-cycle

In this section, the quantitative results of MC1 were reported on. The results of the pre-SRSSL and the post-SRSSL were discussed, followed by a discussion of the results of the pre-TLO and the post-TLO. Spider diagrams depicting the results of the pre-TLO and the post-TLO were also reported on. Finally, the results of the TLO and the SRSSL were integrated. The results of the TLO for the moderate and the high SSL groups were presented, and correlations between results of the TLO and the SRSSL were also reported on. Following the reporting of all the results of MC1, the adjustment of guidelines to be applied in the second meso-cycle (MC2) will now be discussed.

5.1.5 Adjustment of guidelines after the second intervention of the first meso-cycle

When adjusting the guidelines after MC1 INT2, it had to be kept in mind that in MC2, the guidelines would be applied to a new group of participants. In the first intervention of the second meso-cycle (MC2 INT1), all topics of the database module, as in MC1 INT1 (creating database tables, creating relationships, and designing queries), were again addressed. Thus, the factors that hindered transfer during MC1 INT1, as well as participants' experiences of the guidelines, had to be considered when adjusting the guidelines.

From the qualitative results of MC1 INT1, it was evident that participants needed more reinforcement and awareness of the concepts of primary keys and data types (see section 5.1.1.2). Due to issues with problem-solving strategies and creating relationships, it was further

decided that participants required more exposure to possible problem situations and more practice on problems at various cognitive levels, especially with regard to creating relationships. For the adjusted guidelines, the structuring of the module content was kept the same as participants reported positively on how the content of the module was structured (see section 5.1.1.3). First introducing all database objects, to obtain a holistic picture, and then progressing to a more in-depth understanding of each object, while still addressing the other objects.

Although many positive experiences were reported with regard to CL, there were also negative experiences, mostly related to group combinations and passive group members not contributing to their groups, which had to be addressed (see section 5.1.1.3.3). Thus, positive interdependence and individual accountability had to be addressed.

Regarding SDL, non-SDL attitudes and activities were also noted during MC1 INT1 (see section 5.1.1.3.1). Although the introduction of an authentic task could have had some improvement of SDL activities after the second intervention (see section 5.1.2.3.2), participants would not have sufficient knowledge and skills to attempt a task that required such a high degree of self-direction in MC2 INT1. Rather, SDL learning activities and learning strategies had to be nurtured and developed. Extrinsic motivation factors were also prominent during MC1 INT1, and self-efficacy and independence in learning had to be addressed. Table 5.16 and Table 5.17 indicate the adjusted guidelines (see Table 4.3), as well as motivations for the adjusted guidelines in view of the results from MC1. A full explanation of each guideline has already been provided in section 3.6.

Table 5.16: Adjusted guidelines for the first intervention of the second meso-cycle

All guidelines as indicated for the first meso-cycle (see Table 4.2) will again be applied in the second meso-cycle, because positive experiences were reported by the participants. The guidelines below are added to the initial guidelines, to address issues identified in the results from the first meso-cycle.

Guide-lines	Description of adjusted guidelines	Motivation
AD	Focus on guiding students through inquiry activities first and do problem-solving, instead of following a tell-first approach.	Address problem-solving issues.
C, G, H, N, Z, AA	Give a variety of real-life complex problems on various scenarios, to assist learners in recognising deep-structure similarities in problem scenarios, to develop far transfer. Provide more worked-out examples, progressing in complexity. Combine groups to compare and debate their solutions to complex problems, to cultivate the habit of asking good questions, and to foster critical thinking. Focus on comparing and contrasting examples, to identify deep-structure similarities.	Address problem-solving issues, and give more problem-solving activities on creating relationships on various scenarios. Develop interpersonal skills, address the engagement of group members and positive interdependence, and develop critical thinking and interpretation of scenarios.
I	Administer knowledge surveys to students.	Improve metacognitive awareness of learning needs, address SDL activities, and focus on underlying aspects of concepts that have to be enforced.
L	Include metacognitive questioning.	
B	Match the level of SDL required to students' level of readiness, and make progression towards student-directed learning over a period of time.	Make progression towards student-directed learning over a period of time.
AF	Introduce collaboration scripts to inexperienced groups initially. Care should be taken not to allow collaboration scripts to distract participants' attention and thus limit deep processing of content. In collaboration scripts, indicate when to swap roles when engaging in pair programming groups. The driver operates the computer, and the navigator writes answers on scripts and instructs the navigator.	Address negative comments on group combinations and the engagement and contribution of group members. Reduce the extraneous cognitive load imposed by transactive activities, to focus more on finding solutions to problem scenarios.

Table 5.17: Adjusted guidelines for the second intervention of the second meso-cycle

Guide-lines	Description of adjusted guidelines	Motivation
U, V	All guidelines as indicated above in Table 5.16 still apply. However, at this stage collaboration scripts (guideline AF) are no longer required, as group skills have been acquired. Students need to design and do an authentic task as a database project.	Participants should now have developed their group skills and improved their SDL skills and will be more equipped to attempt an authentic task.

In the following section, the results from MC2 will be reported on.

5.2 REPORTING OF RESULTS FROM THE SECOND MESO-CYCLE

Twenty-seven participants gave consent to participate in the research in MC2. The interventions that were applied in each intervention were discussed in chapter 4 (see section 4.2.2.5) and were summarised in Table 5.16 and Table 5.17 above.

As in MC1, the order of reporting for MC2 will be according to the order of data collection (see Figure 4.5). The results of the qualitative data of each intervention will be discussed first, followed by the results of the quantitative data. As indicated for an explanatory sequential approach, the results of the transfer tests (see section 4.4.1.1), however, will each time be discussed before the results of the interviews are discussed.

5.2.1 Reporting on the qualitative results of the first intervention of the second meso-cycle

The order of discussion in this section will be to report on the results of the transfer test after MC2 INT1, and then on the factors that hindered transfer and participants' experiences of implementation of the guidelines.

5.2.1.1 Reporting on results of the transfer test after the first intervention of the second meso-cycle

As already indicated above in the discussion of the results of MC1, the transfer tests determined which participants would be invited to individual and focus group interviews, and they also served as anchor documents during the one-on-one interviews (see section 4.4.2.1.2). The results of the transfer test will therefore be discussed in this section, although it has been indicated that the transfer test is a quantitative data collection method (see section 4.4.1.1). As in MC1, the topics assessed in this transfer test (see Appendix I) were creating tables and defining data types, creating relationships, and designing queries. A different test was, however, set for each meso-cycle. The results of the transfer test are summarised in Table 5.18.

Table 5.18: Results of the transfer test after the first intervention of the second meso-cycle

(N = 27)					
No transfer (< 50%)	Interviewed	Attempted transfer (50%–74%)	Interviewed	Successful transfer (> 74%)	Participated in focus group
5	3	17	5	5	5

All 27 participants wrote the transfer test, as the test was part of the formative assessment of the database module. Five participants obtained less than 50% for the transfer test, 17 participants obtained between 50% and 74%, and five participants obtained more than 74%. Participants were accordingly grouped into the no transfer group (five participants), the attempted transfer group (17 participants), and the successful transfer group (five participants) (see section 4.4.2.1.1).

All participants from the no transfer group and the attempted transfer group were invited to one-on-one interviews. Three participants from the no transfer group accepted the invitation, and five participants from the attempted transfer group accepted the invitation. All five participants from the successful transfer group accepted the invitation to participate in the focus group interview. Thirteen participants thus participated in nine interviews.

In the following section, the qualitative results of the interviews held after MC2 INT1 will be discussed. The factors that hindered transfer will be reported on first, focusing on research aim 4c. The participants' experiences of implementation of the guidelines will then be discussed, to address research aim 4a. Lastly, reporting of the qualitative results of participants' SDL and the categories of the TLO will be done, to address research aims 4b and 4d. Participants that gave informed consent were randomly numbered and these numbers will be referred to in the discussion.

5.2.1.2 Reporting on factors that hindered transfer after the first intervention of the second meso-cycle

In this section, the factors that hindered transfer (research aim 4c) after MC2 INT1 will be reported on. General factors that hindered transfer will be discussed first, followed by factors specifically related to creating relationships and designing queries. It may seem as if participants experienced many issues and were not successful in transfer. The focus of the reporting, however, is on obstacles that hindered transfer, and successful transfer is therefore not reported on in this section.

General factors that hindered transfer are indicated by the red dotted lines in Figure 5.14. These factors emerged as a lack of problem-solving skills (G = 15), issues with reading and

interpreting questions (G = 15), issues with time (G = 12), issues with data types and field sizes (G = 7), a lack of knowledge (G = 3), and verifying solutions (G = 5). These themes will now be elaborated on.

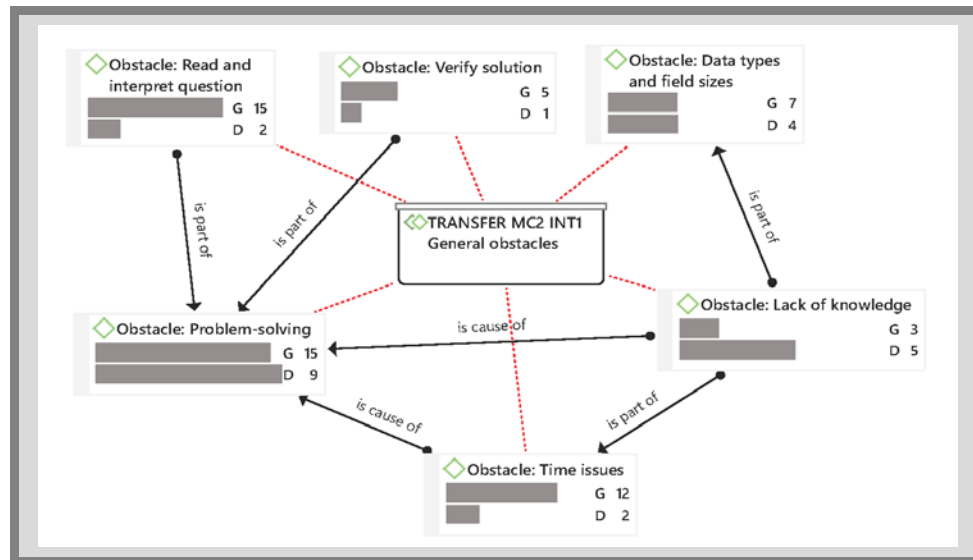


Figure 5.14: General factors that hindered transfer after the first intervention of the second meso-cycle

(a) Lack of problem-solving skills

The theme of lack of problem-solving skills emerged strongly from the data (G = 15). The density of this theme (D = 9) indicates that this theme is linked to nine other themes, therefore implicating and also being implicated by several other factors. Issues with reading and interpreting questions can, for example, be viewed as a cause of problem-solving issues, and, in turn, when difficulty is experienced with problem-solving, issues with time can be experienced, and vice versa. Participant P2c, for example, reported that she used the method of trial and error to correct solutions:

It feels like I will keep on connecting the two things, until it eventually works. So I don't actually understand how it works. I just keep on until it eventually works. (P2c)

Participants experienced several obstacles when troubleshooting relationships. Participants reported that they knew what to do, or what the solution had to look like, but that they lacked the know-how to obtain the solution:

I wanted to link ClientTb's rewards card with RentTb's rewards card, and then ClientTB's rewards card was the primary key, but because of technical reasons, I didn't know how to solve it. I couldn't get it right. (P4c)

I know exactly which relationships I have to create, but my things didn't want to... I have the habit when creating a new table of creating it simultaneously, because when I make the one Integer and the other Integer, then you ensure that when you need to make the connection, everything is in order. But it just didn't want to connect. (P14c)

(b) Issues with reading and interpreting questions

The theme of reading and interpreting questions ($G = 15$) also emerged as a strong factor hindering transfer:

Now that it was set out word for word, I just couldn't form a picture in my mind of what it must look like. (P3c)

Sure, if I understood the question a bit better, then I would have done something. (P4c)

Participants reported that they knew how to solve the problem, but that they just did not focus on the particular question being asked:

I understood everything. I just swopped some of my stuff with what I had to do and what I actually did. Like here with "Change the data type size of all fields", I understood that you had to enlarge the size of the cells, and not that you had to change it here inside the cell. (P6c)

Because participants were rushed, they did not read the questions properly:

It has happened a few times that I'm so rushed. When one doesn't read thoroughly, you miss important information. (P5c)

Participants misread the questions, and when they looked at their solutions again, they realised what their mistakes were:

Oh, I just had to change my field sizes! (P3c)

I don't know why I did it. That's something I don't know, because I know how to do it. Yes, it definitely was a mistake. (P8c)

(c) Verifying solutions

Although it did not emerge as a strong theme, verifying solutions ($G = 5$) was identified as another obstacle to transfer when creating relationships or designing queries. Participants thought their solutions were correct, but only realised later that the output of especially queries was not correct:

According to me, I did put Suzuki in [the condition]. (P6c)

I don't know why he [query] didn't display it. I thought it was the correct way of doing it. (P8c)

Should those little signs not have been there? Is there a problem with the relationship that I did? (P1c)

(d) Lack of knowledge

Although it did not emerge as a strong theme ($G = 3$), lack of knowledge implicated other themes ($D = 5$). Participants P2c and P8c reported that they did not know how to do some tasks. As indicated in Figure 5.14, lack of knowledge could be a cause of experiencing time issues, issues with data types, and problem-solving issues:

I didn't know how to do this. I know I didn't study this. (P8c)

Participant P8c further reported that she could not study, due to extrinsic issues:

I know I didn't study. Definitely in my personal life some things have happened. Not only in this subject, but in all my subjects I've lost the desire to study. (P8c)

Not being motivated due to various extrinsic reasons was further identified as a cause of lack of knowledge. Participant P8c mentioned that she lacked knowledge, as indicated above, but she then explained that she was not motivated to study, due to personal reasons. Participants P4c and P5c also reported that they were not motivated to study, due to extrinsic factors:

I know a certain amount of effort must go in. Intrinsic and extrinsic factors prevented me from putting in the required effort, or from concentrating. (P4c)

(e) Issues with data types and field sizes

Issues with data types ($G = 7$) hindered transfer both when creating relationships and when designing queries. When issues with data types are experienced, several tasks, such as connecting fields in relationships, problem-solving, and formulating conditions in queries (see Figure 5.14), were also implicated ($D = 4$). Although participants knew how to create relationships, the solutions were not correct, because of incorrect data types being assigned to the related fields:

I understand how to start relationships, but to relate the field and data types that's a big factor, I think. (P5c)

All went well, and then he didn't want to work, and I didn't know why. He gave a one-to-one the whole time, and I returned all the time, because you get the message that something's not the same. I think my field size wasn't the same. (P6c)

Still the number, Integer, and so on. I struggle to remember, so it's a bit difficult for me to say which one to choose. (P7c)

Participant P4c explained why she changed the Year field to type "ShortDate" instead of to type "Integer". It was not that participant P4c did not have knowledge about data types; she just used the wrong reasoning to select the appropriate data type:

I felt Time [the data type] wasn't practical. The GeneralDate [the data type] was too long, and if you typed out the month, then it would also be too long, and you just want to see quickly and immediately what the answer is. (P4c)

Participant P4c did not realise that because she had not assigned the correct data type to the Year field, the crosstab query also did not produce the correct output, even though it was set up correctly:

Here I got confused, and how I got it here was still technically not right. (P4c)

(f) Issues with time

Issues with time again emerged as a strong theme ($G = 12$), as in MC1. Participants therefore made unnecessary errors, because of being rushed for time:

This is the first test that we wrote. You are pressed for time. You are unsure. (P1c)

I understood the scenario, but I think because you are stressed, because of time and everything, you forget to answer in full. (P5c)

Because I was so pressed for time, I couldn't... it was difficult to apply it. (P3c)

When participant P4c was asked why she had not attempted to answer a question, even though she had got other more difficult questions right, she replied “*I just ran out of time*”.

All the obstacles discussed above hindered transfer when creating relationships and designing queries. In the following section, other obstacles that specifically hindered transfer when creating relationships will be elaborated on.

5.2.1.2.1 Factors that hindered transfer when creating relationships after the first intervention of the second meso-cycle

Figure 5.15 displays the obstacles that participants experienced specifically when creating relationships. Creating a relationship between two tables in Microsoft Access can be described as a complex task, as many interrelated factors that can hinder transfer when executing the task were identified (see Figure 5.15). In section 5.2.1.2 above, general issues also depicted in Figure 5.15 have already been reported on. In this section, identifying fields to connect (G = 10), misconceptions related to primary keys (G = 6) and deleting relationships (G = 2) will be reported on. These themes are specifically identified as factors that hinder transfer when creating relationships.

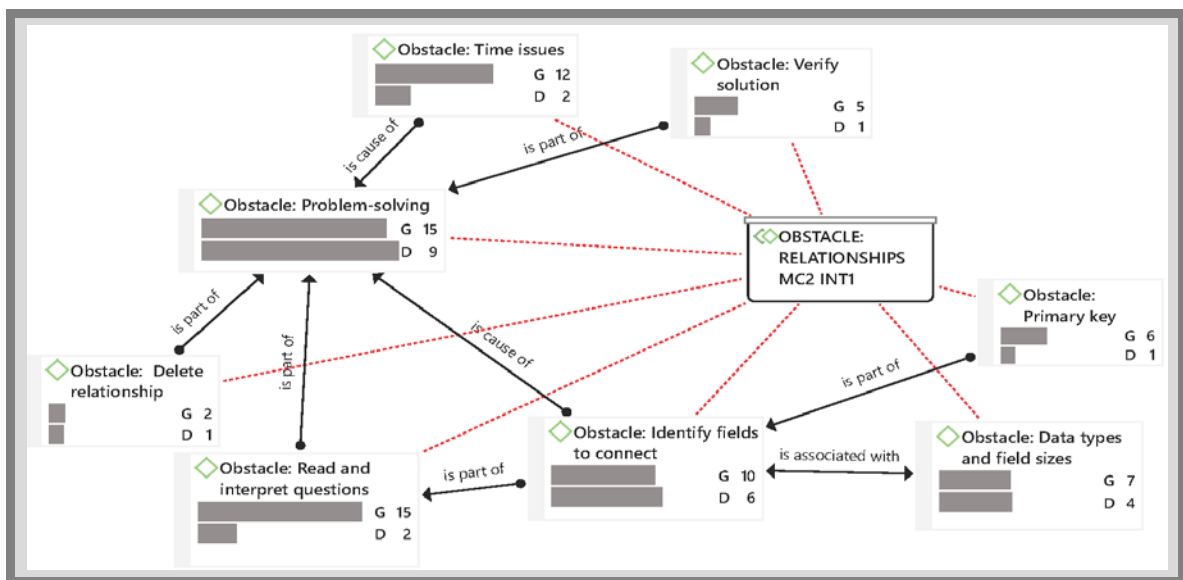


Figure 5.15: Obstacles experienced when creating relationships after the first intervention of the second meso-cycle

(a) *Identifying fields to connect*

Participants reported that because they could not identify the fields to connect in the relevant tables (G = 10), they could not create the required relationships:

For me, to create a relationship in Access is OK, but when there are many tables or I need to create the table myself, then it becomes difficult for me, because I don't always know what to put in to create a relationship. (P7c)

I didn't know what to connect with what. Definitely something I didn't know. (P8c)

(b) Misconceptions related to primary keys

Primary keys in tables are fundamental when creating relationships. Some participants reported having misconceptions about primary keys ($G = 6$). When assigning primary keys, these participants focused on the uniqueness condition, but not on other conditions, such as that primary keys should not change in value, or that the primary key should always contain a value. Participant P1c reported that she chose the cell phone number as the primary key, because a cell phone number is unique to a person. She, however, did not take into account that cell phone numbers can change, or that some people might not have cell phone numbers:

I used the cell phone number, because it's unique to the person. (P1c)

Participant P4c made the rewards card field the primary key. As with participant P1c, her reason for doing so was that the rewards card is unique to a person, but she did not take into account that not all clients have a rewards card. Thus, she was not able to create the relationship:

He [the rewards card] helps me to identify the client. I wanted to make the rewards card the primary key in the other table, but then he didn't want to work. (P4c)

Participant P7c reported that a primary key should be unique and it should not change. The name field that she assigned as the primary key, however, did not satisfy the uniqueness condition:

I thought, you know, a first name isn't really something you're going to change. I think a cell phone number can change, an email address can change, a street address can change. I could probably have made the date of birth the primary key, because you can't change your date of birth. So that's what I thought. It's just to indicate unique fields and something that cannot change. (P7c)

(c) Deleting relationships

Although it did not emerge as a strong theme, some participants could not manage to delete incorrect relationships, and thus could not correct them:

The scenario wasn't the problem for me, but I tried to delete the vehicle's table [the relationship with the table], but when I added it again, it automatically made the relationship it had with the previous one, so I couldn't change... or I didn't know how to change him. (P1c)

5.2.1.2.2 Factors that hindered transfer when designing queries after the first intervention of the second meso-cycle

Figure 5.16 displays obstacles that participants specifically experienced when designing queries, and which thus hindered transfer. In section 5.2.1.2 general issues (as indicated in Figure 5.14) have already been reported on.

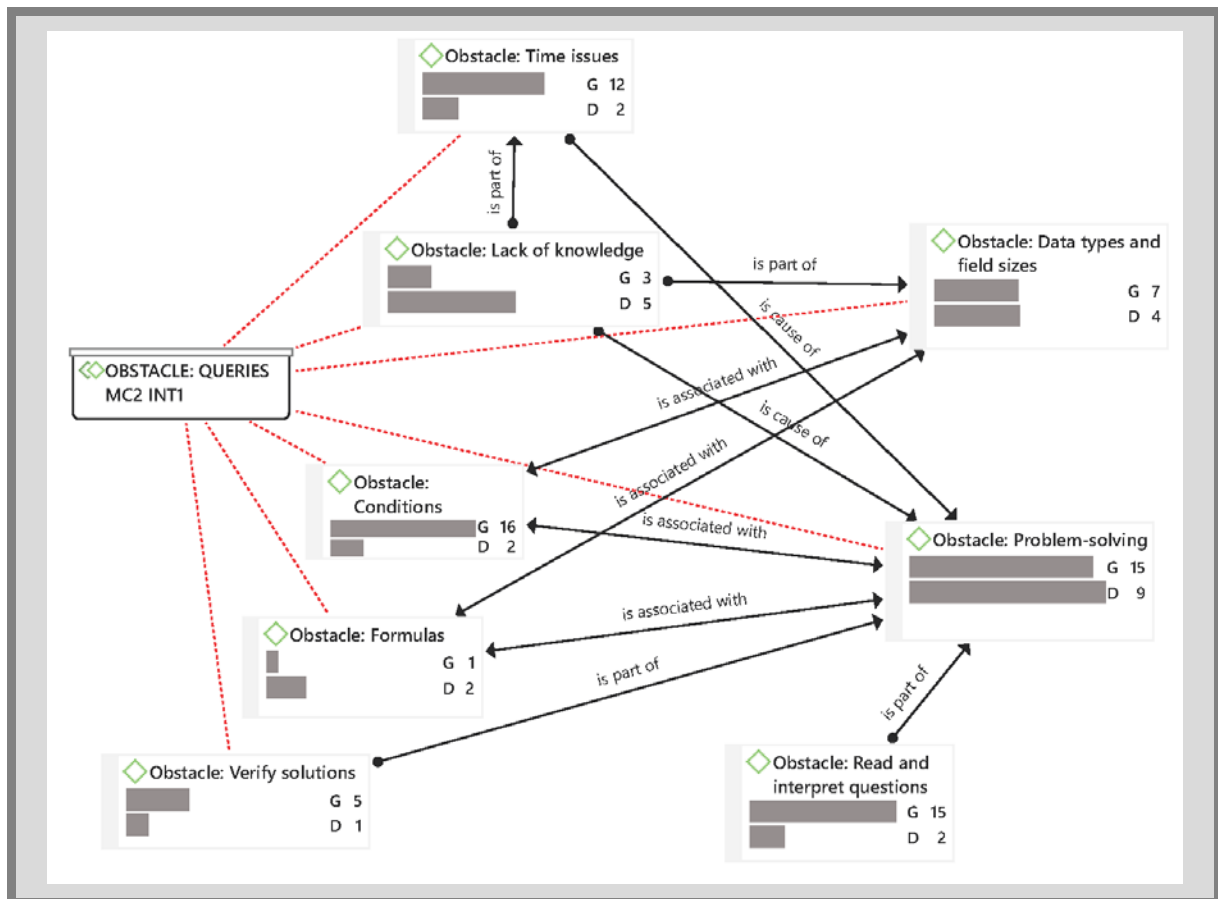


Figure 5.16: Obstacles experienced when designing queries after the first intervention of the second meso-cycle

As depicted in Figure 5.16, designing queries also involves many interrelated factors. Participants need to read and interpret the question (G = 15) and plan a solution. The solution will entail developing criteria to set up specific conditions (G = 16) or devising formulas (G = 1) to obtain the required output. The solution needs to be verified (G = 5), and it must be determined if the output that has been obtained is that which is required. If it is determined that the output is not that which is required, or other unforeseen errors have occurred, problem-solving (G = 15) should be done. When there are time issues, such as when participants rush because of fear of not completing in time (G = 12), or because of a lack of knowledge (G = 3), all the above-mentioned factors are impacted even further.

Difficulties with formulating criteria emerged as a strong theme from the data. Participants reported that they found designing queries to be quite challenging, because certain criteria or conditions have to be formulated:

And then very much the queries. The criteria. That was my biggest problem. (P2c)

Definitely the functions and formulas we use in Access I still have to master. Especially here where we had to find the "50" in the number plate, it was hard for me. (P1c)

How to get the formulas and the caption. The AND and the OR, that I struggle with. (P4c)

All other obstacles that emerged from the data have already been reported on in section 5.2.1.2.

In this section, factors that hindered transfer related to creating relationships and designing solutions for queries were discussed. In the following section, participants' experiences of the implemented guidelines during the MC2 INT1 will be discussed.

5.2.1.3 *Reporting on participants' experiences of implementation of the guidelines in the first intervention of the second meso-cycle*

In this section, qualitative results related to participants' experiences of the implemented guidelines will be discussed. Qualitative results related to SDL and themes related to the categories of the TLO will be discussed first. Thereafter, participants' experiences of CL will be discussed.

Although participants were expected to work self-directedly, which demanded a lot of effort and input from their side, they enjoyed the teaching-learning strategy, and they felt that learning had taken place:

It's good for me. I like the self-directed learning. I like to explore and to figure it out myself, and if I don't get it right, then to ask. (P7c)

I really feel it's sometimes a bit difficult. But I think at this level, especially because it's a practical subject, you're not supposed to spoon-feed a person. On the contrary, the person must sit down and do self-study and make sure they understand it and know how it works. (P8c)

Participants reported that at school they did not enjoy Access. They, however, enjoy the subject now and understand its purpose:

I had it at school, but this [Access] is also the thing I didn't like, and I didn't work very hard. So now I can learn a little more. (P2c)

It's really nice for me, and I now enjoy the subject. I mean, at school I didn't like much of it. I didn't like Access because... Actually, people make Access such a difficult subject, and actually, it's not difficult. You just need to understand the concept of how everything works. (P12)

5.2.1.3.1 Qualitative results related to self-directed learning after the first intervention of the second meso-cycle

Participants reported on SDL activities and characteristics, but also on attitudes and practices that do not agree with SDL (see Figure 5.17). These themes will now be reported on.

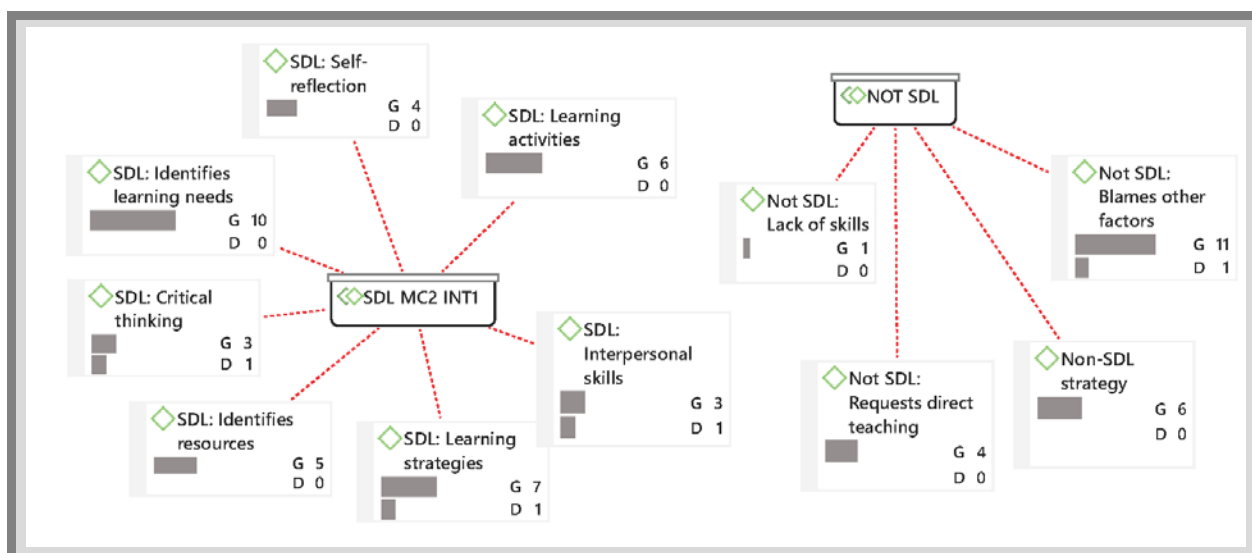


Figure 5.17: Qualitative results related to SDL after the first intervention of the second meso-cycle

(a) Self-directed learning characteristics and activities

Participants reported that they identified their learning needs (G = 10), they identified resources (G = 5), and they applied SDL learning activities (G = 6) and strategies (G = 7). Some also indicated that they reflected on their learning (G = 4). Good interpersonal skills (G = 3) and critical thinking (G = 3) also emerged as themes.

A strong theme that emerged was that participants identified their learning needs:

I went looking for another way to create the relationship. (P1c)

I have a file in which I usually put my activities of what we do in class, and obviously my notes that I make in class, so I usually look at it before a test, and then I go and see where I made my mistakes. Then I, for example, do the test again, and then I say, "OK, but I made a mistake here. Let's see how to fix it right away. How... what did I do... what did I do wrong?" (P3c)

Participants reported that they reflected on their learning:

You think about everything that has happened to you, and then all the solutions come up. (P4c)

The learning activities and strategies that participants reported on indicated that they were self-directed in their learning:

So I will say it's sometimes difficult, but that's better for me than when someone is sitting in front of you now and saying, "OK now, go to this, and go to that." So I feel the approach is definitely appropriate. That's it... that's right. (P8)

Yes, look, there is no time to explain everything in class. We have to do the preparation on our own. (P13)

I took the study guide, then I looked at the outcomes, and then I did all the activities we did during the semester. I took old exam papers and looked at what we had done, and I

applied those questions in a way on stuff and information I already had. That's how I prepare for all my tests, and then I sum up and see what I don't understand. (P6c)

Participant P12c did not have a textbook at one stage, but she reported that she still prepared for class:

Fellow classmates sent me a photo every night, and then I prepared. (P12c)

Participant P13c reported that she did additional activities, and participant P11c felt that one can never do enough examples:

Yes, I also did the preparation for class, and I not only did just lab 1 and lab 2; I also did lab 3. And that gave me that extra preparation. (P13c)

I don't think you can ever do enough examples. (P11c)

The themes of good interpersonal skills and thinking critically will be reported on in section 5.2.1.3.3, in the discussion of participants' experiences of CL.

(b) Non-self-directed learning practices

Although participants reported on SDL activities, some referred to practices that are in conflict with being self-directed in learning. Some participants mentioned that they wanted more direct instruction (G = 4) and explanation of how to do tasks in Access:

If we can just start going through the queries a bit and maybe just see what we need to type when we get scenarios of the criteria – how or what we need to type. (P2c)

I think if we talk a little more intensively about the work, for example explaining how to do it, step by step. (P3c)

Participants often blamed other factors (G = 11) for poor performance, such as not having textbooks, sport commitments, noise at the students' residence, and other personal factors:

Many people don't have textbooks, and that's why they're performing poorly. (P8c)

Extrinsic factors also play a role at the residence. (P4c)

It's also difficult to get to tutor classes, because I also play [name of sport]. (P5c)

Some participants acknowledged that they did not prepare, or that they were not sufficiently prepared, for the test:

It was now quite difficult for me, because the crosstab query for me was... I had learnt it, but I didn't learn it in detail, because it was very new to me, and I should have looked at it again, I know. (P3c)

I wasn't sufficiently prepared. That's what I honestly think, because I didn't prepare. (P8c)

In the following section, qualitative results related to the categories of the TLO will be reported on.

5.2.1.3.2 Qualitative results related to the TLO after the first intervention of the second meso-cycle

Figure 5.18 depicts the categories related to the TLO that emerged from the data in MC2 INT1.

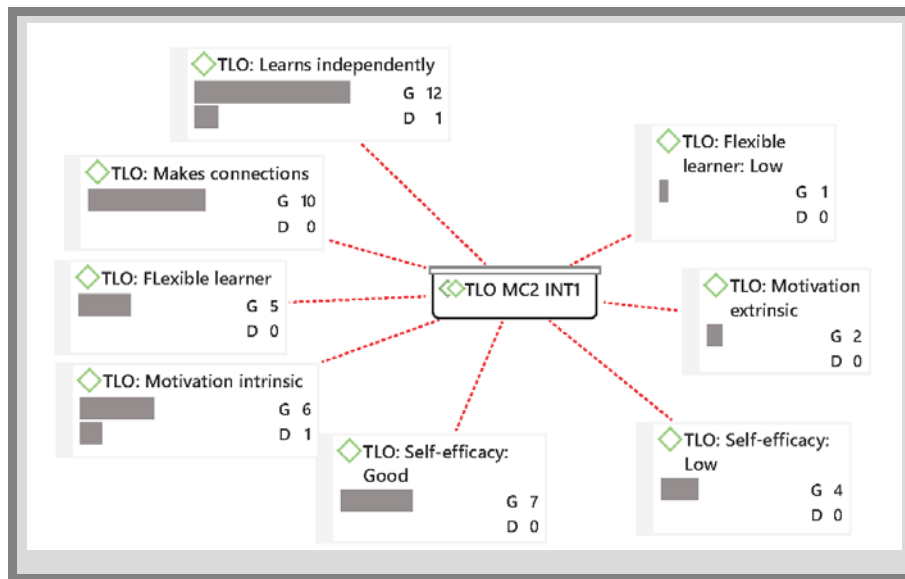


Figure 5.18: Qualitative results related to the TLO after the first intervention of the second meso-cycle

The categories of the TLO that emerged most strongly from the data were “learns independently” (G = 12) and “makes connections” (G = 10). Other themes that emerged were good self-efficacy (G = 7), being flexible in learning (G = 5), and being intrinsically motivated (G = 6). In the second meso-cycle, an additional category, namely motivation by extrinsic factors, was added to the categories of the TLO (see section 5.2.4.2), and it emerged as a weak theme (G = 2) from the qualitative data. Themes related to low self-efficacy (G = 4) and not being a flexible learner (G = 1) also emerged from the data, although they were not prominent themes. These themes will now be reported on.

(a) Results for “self-efficacy”

Participants reported that they felt confident about themselves and that they understood the work (G = 7):

I understand everything. I know exactly what it means, and I know what to do. (P8c)

I didn't even learn very hard for the test, because I knew how to do it. (P13c)

A few participants (G = 4), however, did not feel that confident. The complexity and the difficulty of the work made them doubt themselves:

I understand the basic concept of the relationship, but now one goes to normalisation, and you have to draw those things, and it becomes a bit too much for me now. (P7c)

Because it's not a concept that I understand 100% now, I doubt myself whether I'll know if it will be right. (P11c)

(b) Results for “flexible learner”

Flexibility in learning (G = 5) emerged as a theme mostly when participants indicated that they were willing to adapt and work in groups and to be open to other ways of solving problems and working in Access:

Because then maybe I can say, “OK, you did it like this. Let’s try another way, then, how one might do it in a different way, how one can do it in another way like that.” (P3c)

I’m not fond of group work, but it also does work, because I can learn from someone else. They may know something I don’t know, and if I have to explain what they don’t know, then I’ll learn again. It’s also good for me. (P7c)

Although participant P7c considered herself an introvert and was therefore not fond of working in groups, she was willing to work in groups, and she also admitted that she enjoyed it:

I’m not crazy about group work, but it does work, because I can learn from someone else, because I have to communicate with other people that I don’t really know. I’m a bit socially awkward. (P7c)

Only one quote was linked to not being flexible in learning. Participant P1c indicated that she was set in her ways, and was therefore not flexible in her learning. She mentioned that she did not want to be the navigator when engaging in pair programming activities:

I’m a “Monkey see, monkey do” person. So don’t work without me. I want to see and do, then half of the time you’re navigating, and the other half you’re doing, and then you struggle to do what you’ve navigated before. (P1c)

(c) Results for “learns independently”

A prominent theme that emerged was that participants could work independently (G = 12). They also indicated that they would also ask for help if needed:

So if I go through my own things, then I know, “No, OK, I understand this, and that I don’t understand.” And then I can go ask about it. (P6c)

I like to explore it and to figure it out myself, and if I don’t get it right, then to ask. (P7c)

(d) Results for “makes connections”

Making connections emerged as a strong theme (G = 10). Participants visualised the scenarios and reported that they could apply the various scenarios when creating relationships:

I could see the scenario as a picture, so at least I could see, “OK, here’s a vehicle.” And then it’s the vehicles that are here, and then how they’re sold. (P3c)

Then my brain got a pattern. Then there was like a green light. (P11c)

If you put yourself in that scenario and try to visualise how it works, how the whole system works, then it’s going to be easier. (P12)

(e) Results for “motivation”

Mixed results were obtained for the theme of motivation. Some participants were motivated by good marks, and thus by extrinsic factors (G = 2), and others reported that they enjoyed the subject. Enjoyment was linked to the theme of intrinsic motivation (G = 6).

Participant P12c reported that it helped her before when she was forced to submit assignments because they counted for marks. She realised, however, that that was not an indication of being self-directed in learning:

It has helped a lot, because it forced you, to some extent. It's actually wrong, because you have to be able to apply that self-directed learning and do it yourself. (P12c)

Other participants reported that they enjoyed the fact that they were expected to work self-directedly and be prepared:

It's good for me. I like the self-directed learning. It's about marks, but when we have to hand in an activity, then by doing this we do self-directed learning, because I learn while doing these activities. This is what motivates me now. (P7c)

I enjoy being prepared. (P11c)

It took me a while [to do the assignments], but I enjoyed it. It was actually rewarding. (P12c)

5.2.1.3.3 Participants' experiences of implementation of the guidelines for cooperative learning after the first intervention of the second meso-cycle

Figure 5.19 indicates the themes that emerged related to CL. Participants reported that they experienced CL positively (G = 6). Participants further mentioned that they found it beneficial to see the views of others (G = 6) and how other students solved problems, which developed their critical thinking. A few negative experiences also emerged from the data (G = 4). These themes will now be elaborated on.

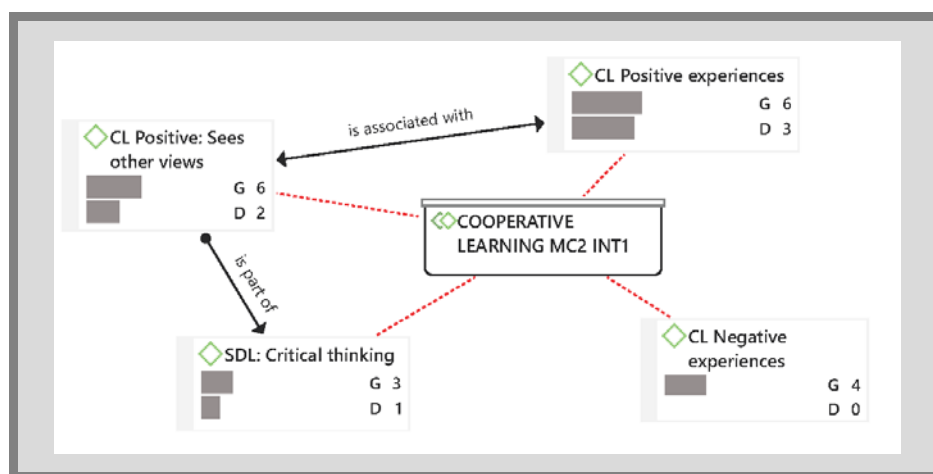


Figure 5.19: Participants' experiences related to CL after the first intervention of the second meso-cycle

Participants reported that they preferred working in CL groups when studying difficult subject content or when working on new concepts:

With difficult things I enjoy it [CL], because I can discuss them with someone else. (P3c)

It [CL] sometimes works better than at other times, like with new concepts. (P4c)

Participant P1c, who mentioned above (see section 5.2.1.3.2) that she did not find it beneficial to be the driver in pair programming, now had a different opinion. She mentioned that she preferred to design ER diagrams in groups, to exchange thoughts with group members. (The reason participant P1c reported on ER diagrams at that stage was because she scheduled her interview late, when ER diagrams had already been introduced in class.)

But the ER diagrams and so are nice to do in a big group, because you can exchange opinions and hear what the other person says, rather than just writing down your own thoughts and you don't really know if you're right. (P1c)

Participant P3c mentioned that she found it interesting to see how the other person will solve the problem, and that she enjoyed the experience of reasoning with others about a solution and seeing a different way of doing things:

But it's quite interesting to me how someone else thinks differently from you, because your intention of how to do this is very different from what she or he wants to do in class. So it's nice for me to say, "OK, she does it this way, but I never thought I would do it that way." How we reason about a matter, that's something quite different for me. (P3c)

Participant P4c reported that debating about a solution gave her the opportunity to think critically:

When we can't get consensus on the answer, then it forces you to think critically and to make sure that your answer is right. You have to think critically when you study, otherwise it will only be superficial and not a good learning experience. (P4c)

Participants also agreed that working in groups and being exposed to the different views of group members is a learning experience:

You obtain insight into what the other person thinks, which you may not have thought of, and then you get an idea of what someone else thinks and how you can integrate it. (P6c)

It's good. I like it. I'm not fond of group work, but it does work, because I can learn from someone else. I like it too. They may know something I don't know, and if I have to explain what they don't know, then I learn again. It also works for me. (P7c)

I like it when we first do the class tests alone. Afterwards, when you do them with someone, then you actually learn from each other's mistakes. (P10c)

Although it did not emerge as a strong theme, some negative experiences of CL were also reported, mostly by participants from the successful transfer group. These experiences were because of fellow students that came to class unprepared, or group members that did not contribute to their solutions:

I especially think for me it's a very difficult thing to handle, because either the person is motivated and she wants to work with you or they come, and I want to say it now, but I think it's often those people who come to class unprepared, that don't really feel anything for the class, and we who want to get good marks... want to perform well, so that you're able to understand the work. And that's why you put in that extra effort, but the people who are just there because they have to come and study they are the ones that make it difficult. (P14c)

What I just experienced with the person with whom I was... I did mine individually, and when we had to do it together, then she said, "OK, but yours is right." She had nothing to contribute, so you learn nothing from it. (P12c)

Participants from the successful transfer group, however, further mentioned that they at that stage were at peace with the fact that other students often relied on them when working in groups:

I think we have made peace with the fact that we are always the ones who know the answers. (P11c)

5.2.1.4 Conclusion of discussion of the qualitative results of the first intervention of the second meso-cycle

In this section, the qualitative results of MC2 INT1 were discussed. Factors that hindered transfer were indicated, and participants' experiences of the implemented intervention were reported on. In the following section, the qualitative results of the second intervention of the second meso-cycle (MC2 INT2) will be discussed. At that stage no recommendations for adjusted guidelines were given. The guidelines as determined for MC1 INT2 (see Table 5.17) were again implemented, and participants had to do a project in the form of an authentic task. At this stage, however, collaboration scripts were no longer required, as participants had acquired group skills.

5.2.2 Reporting on the qualitative results of the second intervention of the second meso-cycle

In this section, the results of the transfer tests for MC2 INT2 will first be discussed. Thereafter the factors that hindered transfer will be reported on, followed by participants' experiences of the intervention.

5.2.2.1 Reporting on results of the transfer test after the second intervention of the second meso-cycle

All 27 participants wrote the transfer test after MC2 INT2 (see Appendix J), as it was part of the assessment plan of the module. The topics assessed in the test were the same as those of the corresponding transfer test in MC1 INT2 (normalisation, designing of ER diagrams, and creating relationships) (see section 5.1.2.1), but a different test was set in MC2. The results of the transfer test are summarised in Table 5.19.

Table 5.19: Results of the transfer test after the second intervention of the second meso-cycle

(N = 27)					
No transfer (< 50%)	Interviewed	Attempted transfer (50%–74%)	Interviewed	Successful transfer (> 74%)	Interviewed
13	2	13	3	1	1

Thirteen participants obtained less than 50% for the test, and 13 obtained between 50% and 74%. As only one participant obtained more than 74%, all participants were invited to one-on-one interviews after the second intervention. Six participants accepted the invitation for interviews. Two participants from the no transfer group, three participants from the attempted transfer group, and one participant from the successful transfer group were interviewed. As in MC1 INT2, the low number of participants that agreed to be interviewed could possibly be attributed to the time of the year. The semester was coming to an end, and the end-of-year examination was drawing near.

5.2.2.2 Reporting on factors that hindered transfer after the second intervention of the second meso-cycle

Figure 5.20 depicts the factors that hindered transfer after MC2 INT2. General themes that emerged from the data corresponded to obstacles that have already been reported on in the discussions above (see sections 5.1.1.2, 5.1.2.2 and 5.2.1.2) on factors that hindered transfer. Themes related to issues with time (G = 16) and reading and interpreting questions (G = 9) again emerged from the data. Two quotes were linked to having difficulty with problem-solving. Some participants still experienced obstacles related to primary keys (G = 2), data types (G = 3), and identifying fields to link in relationships (G = 3), although these obstacles seemed to be on a smaller scale than was the case after the other interventions that have been reported on. Due to the fact that these themes have already been extensively reported on, they will not be elaborated on in this section.

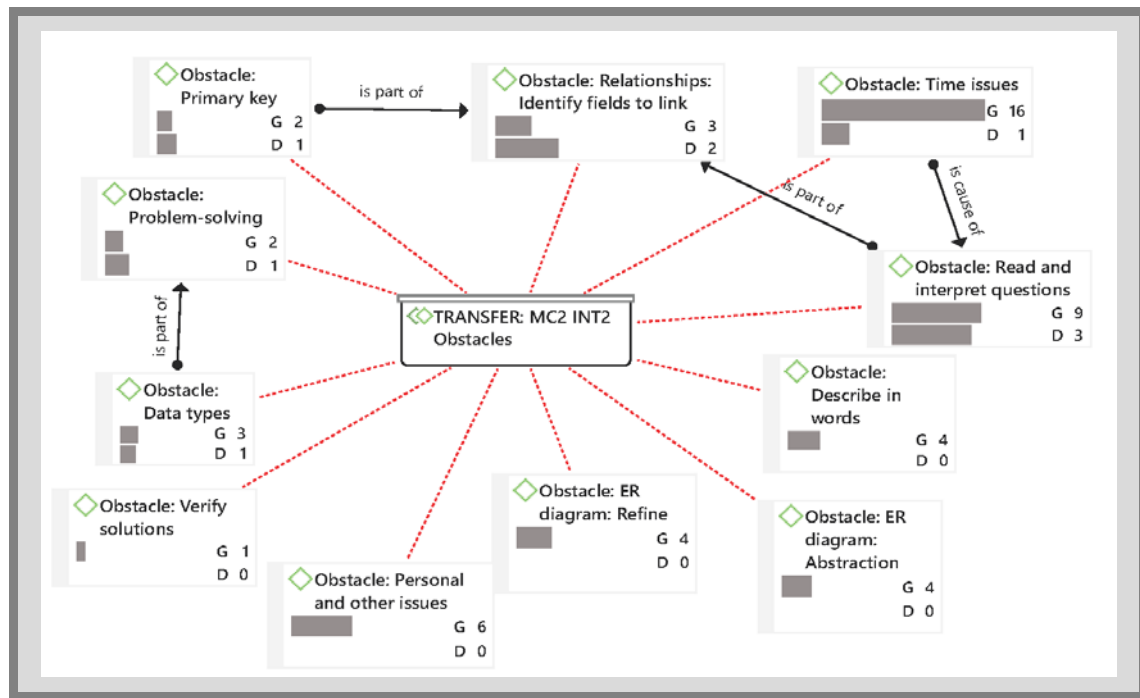


Figure 5.20: Factors that hindered transfer after the second intervention of the second meso-cycle

A theme that emerged from the data was personal issues, such as headaches and anxiety that participants P2d and P4d experienced, which hindered transfer. Due to reasons of confidentiality, no further reporting will be done on this theme.

In the following section, factors that hindered transfer specifically when designing ER diagrams will be discussed.

5.2.2.2.1 Factors that hindered transfer when designing ER diagrams after the second intervention of the second meso-cycle

One of the first steps when developing a database is to design an ER diagram. This can be described as a complex task. A scenario has to be interpreted, and an abstract diagram according to a specific syntax has to be designed to indicate the relationships between various entities. Apart from all general obstacles mentioned in section 5.2.2.2, factors that hindered transfer when specifically designing ER diagrams emerged as abstract representation (G = 4), and refining ER diagrams (G = 4) (see Figure 5.20).

Participants could often correctly describe the relationships between the entities, and they indicated that they understood the given scenario. They, however, could not convey their understanding when drawing the abstract diagrams:

I understood it [the scenario]. I just indicated it wrong. (P2d)

There I said exactly what I didn't want to do. (P5d)

Participants reported that they were aware that all relationships in their ER diagrams had to be depicted as one-to-many relationships. Although they realised that the diagrams had to be refined, some participants only changed the many-to-many relationships to one-to-many relationships:

I knew that it shouldn't be a many-to-many. According to the scenario, it would be many-to-many. (P5d)

I understood the ER diagrams, except for the fact that I had to refine them more. (P1d)

Other participants prematurely submitted the unrefined version of the diagrams:

I should have gone further, but I didn't. (P3d)

In this section, general factors that hindered transfer (see section 5.2.2.2), as well as factors specifically related to ER diagrams, were reported on. No themes emerged on obstacles with normalisation, as in the first meso-cycle (see section 5.1.2.2.1). In the following section, participants' experiences of the implemented guidelines will be discussed.

5.2.2.3 Reporting on experiences of implementation of the guidelines after the second intervention of the second meso-cycle

Participants in general reported positively on their experiences of the implemented guidelines (G = 7), as depicted in Figure 5.21. The benefits of the authentic task (the project) emerged as a strong theme (G = 16). Only two comments were specifically related to CL. One participant reported on a negative experience. These themes will now be elaborated on.

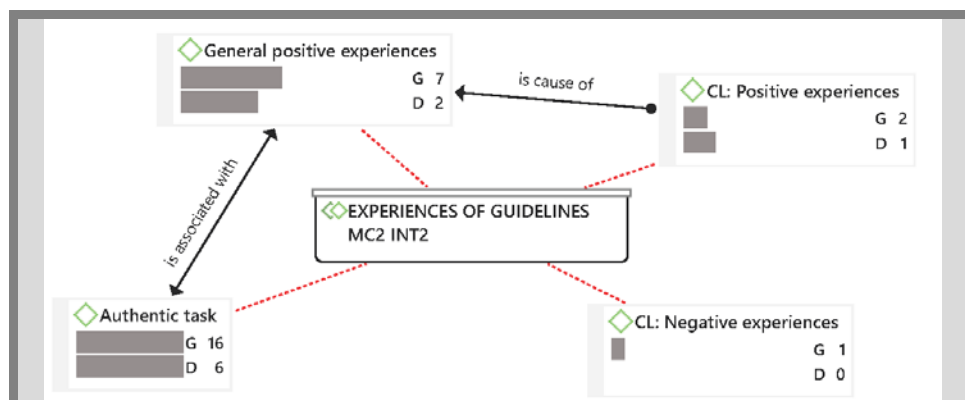


Figure 5.21: Experiences of implementation of the guidelines after the second intervention of the second meso-cycle

Participants gave positive feedback on their experiences of the implemented guidelines:

It's very nice. We have to explore ourselves. We don't get all the answers and aren't spoon-fed. (P2d)

I enjoy what we do in Access. It's really nice. I can learn to do it myself and apply it in the test. (P3d)

I think it's effective, because we have to learn ourselves and do the activities ourselves. (P6d)

Participant P3d mentioned that she felt that the second transfer test was more difficult than the first transfer test, and that she was therefore proud that she managed to improve on her previous mark:

I found the test more difficult than the previous test. It was really a difficult test. Because I got it right, I felt like "Wow! I improved my mark in a test that was actually more difficult". (P3d)

Participant P2d mentioned that with CL she could see other participants' views and ways of doing relationships. Although the solution that she had in mind was correct, she did not want to argue with the group, and so they submitted a wrong solution. She further mentioned that she learnt from the experience, and that in future she will stand her ground:

I listened to her, and thought, "OK, it can possibly be done in another way." Then we did it together... We combined it [the solution], mine and hers. [...] We also found out from other groups how they had done theirs, and they had also done it the way I did it on my own first, but I just left it there. In future I will rather debate it. (P2d)

Only participant P1d reported on a negative experience. She mentioned that in group settings she always had to do the work and explain to others, and she therefore felt that she did not achieve learning gain. She, however, also mentioned that she saw herself as a self-directed learner, that the methods applied in class made her more self-directed, and that she had a good experience of the teaching-learning strategy applied in class:

They will, for example, not have any opinion, and then I don't learn. When they don't understand, then I have to explain why I did it. I prefer the task always to come to me in the end, because I'm a perfectionist, so that I can do everything, because it means marks. (P1d)

It's a good experience. I feel I'm a self-directed learner. I feel I learn more by being someone that's motivated, self-motivated, to do their work. Nobody needs to tell them to do it. Someone that plans. No one needs to tell you to do it. (P1d)

A strong theme that emerged was the positive comments that participants made about the project (the authentic task). Participants reported that when doing the project, they identified learning needs, they achieved learning gain, and they understood concepts that they did not understand before. They also found out on their own about concepts that were not addressed in class. They further reported that although the project was a lot of work, they enjoyed it:

I literally had to go find things in my textbook that I didn't know before. We haven't yet done that [concept]. I had to search in YouTube. I now understand it very well. (P1d)

I now enjoy databases a lot, because we did the project. I learnt a lot of new things. (P2d)

I now understand relationships, with the project that we did. (P5d)

I got very confused with input masks and validation rules. After the project we did, I now got it right. (P3d)

The themes that emerged from comments on the authentic task can be related to both SDL and the categories of the TLO. In the following section, participants' experiences related to SDL and the categories of the TLO will be elaborated on.

5.2.2.3.1 Experiences of guidelines related to self-directed learning after the second intervention of the second meso-cycle

Figure 5.22 depicts the themes related to SDL that emerged from the data. The theme of applying SDL activities (G = 14) emerged strongly from the data. Other themes were SDL strategies (G = 3), identifying learning needs (G = 9), identifying resources (G = 6), and self-reflection (G = 1). Themes also emerged that were related to non-SDL activities, and they will also be reported on.

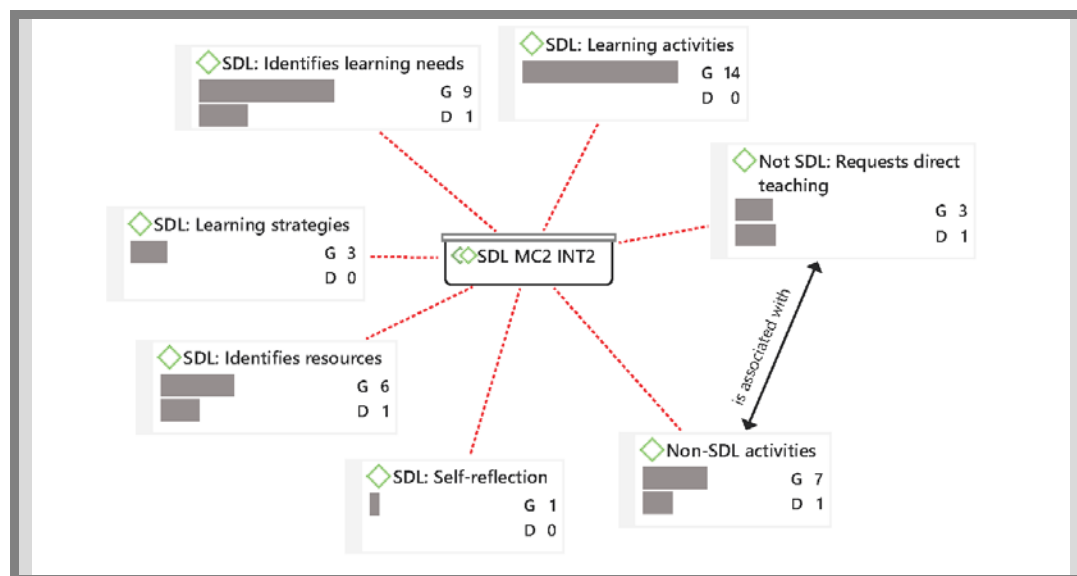


Figure 5.22: Themes related to SDL after the second intervention of the second meso-cycle

All participants except for participant P4d reported that they prepared for class. Participants often searched for new resources online to explain and find clarity on concepts:

Like when you want to put in a query and there is, for example, a validation rule or input mask that you need. Or, for example, with the Lookup Wizard, I wanted to see on YouTube exactly how it works. (P3d)

It was a question that we didn't have to do, and I did it. I then realised how the IF statement works. I searched on the Internet, and it was difficult to find such an IF statement with an AND inside. It really challenged me. (P5d)

Participant P6d mentioned that she specifically found the knowledge surveys helpful. They made her aware of aspects of the work that she would not have thought of:

Those surveys helped me a lot, because some of the things I hadn't looked at. From the survey I made notes about what I should look at again. It really helped a lot, yes. (P6d)

Another theme on SDL that emerged was that participants applied SDL strategies. They started working on their project early (during the recess), they planned for specific time slots to work on their projects, and they kept notes of their learning needs:

I usually make notes. I forgot this, or I couldn't get this right. I say to myself, "I struggled with this and this. Let's google this. Let's work it out." (P3d)

[Name] and I worked together. I told her, "From 9 to 12, then we take a break." (P1d)

Especially when doing the project, as already indicated above, participants reported that they were motivated to master concepts and find resources:

With the project, it took me a long time to sort it out, but I eventually got it right. (P6d)

All comments linked to the theme of non-SDL activities (G = 7) were made by participants P2d and P4d. Although participant P2d reported that she worked according to a time schedule, she also made contradictory comments. She said that she did not allow enough time to prepare for the test. She mentioned that when she comes across something that she does not understand, she will either leave it or ask her friend. She, however, put in more effort for the project and did some research, as the project counted for marks:

I came home at 3 [in the morning] and just quickly went through the work. With the project, I did research and sometimes looked for an answer, because it counted for marks. I had to do it right. Most of the time with theory, I will just leave it if I don't understand. (P2d)

I started [to study] too late. I didn't know the work. (P4d)

Participants P2d and P4d were also those who requested more direct teaching:

With relationships, I would rather have said that ma'am should explain it to us first, but that's just how I am. (P2d)

5.2.2.3.2 Experiences of guidelines related to the TLO after the second intervention of the second meso-cycle

Qualitative results of MC2 INT2 that can be related to the categories of the TLO will now be reported on. Themes that emerged from the data are depicted in Figure 5.23. Strong themes that emerged were the themes of learning independently (G = 14) and good self-efficacy (G = 11). Participants' comments were also related to making connections (G = 8) and being intrinsically motivated (G = 7). No comments were linked to the theme of being a flexible learner. Some comments were, however, related to the themes of low self-efficacy (G = 2) and extrinsic motivation (G = 3).

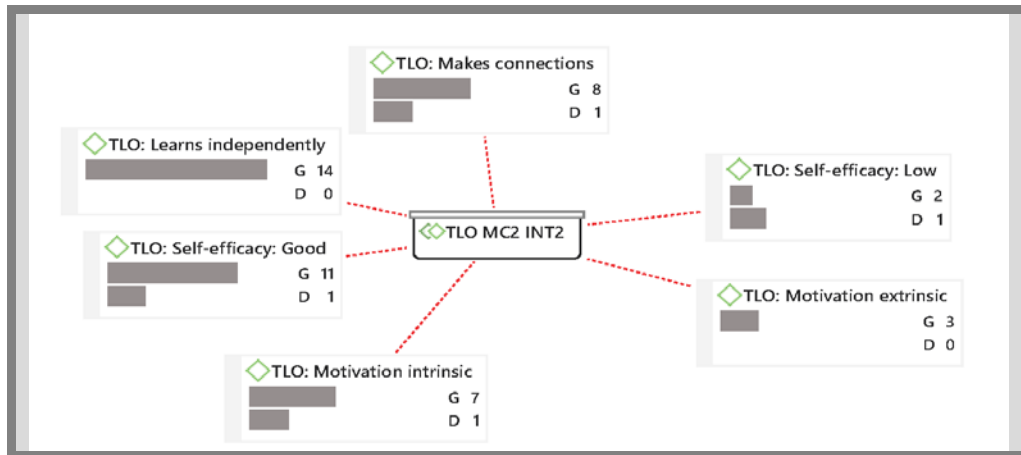


Figure 5.23: Experiences of guidelines related to the TLO after the second intervention of the second meso-cycle

(a) Results for “learns independently”

Participants often reported that they could learn independently (G = 14) and figure out unclear or difficult concepts:

When I didn't quite understand, I took the textbook, and to see it more visually, I used YouTube. (P2d)

When I struggle on my own, I am inclined to understand better when I sit on my own and figure it out myself. If I get it right, I remember it. (P5d)

So if I go back to study it, I'll practise it again, and I'll get it right. (P3d)

(b) Results for “self-efficacy”

From the data, having good self-efficacy emerged as a strong theme (G = 11). Participants reported that they felt confident about concepts:

At the moment I more or less understand everything. I can do it. I can accomplish it. (P2d)

Now that I know the difference, I won't get confused again. (P3d)

I did a lot of formulas in this assignment [the project]. Yes, I'll be able to do it now. (P5d)

Comments made by participants P1d and P4d were linked to the theme of low self-efficacy (G = 2):

I don't know if I understand. (P1d)

So it's basically between “know”, “being uncertain”, and “struggle”. (P4d)

(c) Results for “makes connections”

From the data it emerged that participants were inclined to make connections (G = 8) to other scenarios:

I tried to reason it out logically. I put myself in the scenario. For example, if a client were to phone me now, wanting to make a reservation, what would the procedure be? What steps would you follow? (P5d)

I think like in organic chemistry, where carbon dioxide can have four connections. (P4d)

I had to think for a while about how I'm going to do it, but it helped, because I could apply it in my own situation. (P6d)

(d) Results for “motivation”

All the participants except for P4d made comments that could be linked to intrinsic motivation (G = 7). Participant P5d put a lot of effort into her project, as she was working on a scenario that she was passionate about. Participants also mentioned that being prepared was for their own benefit, and that they placed less emphasis on doing activities for marks:

I put in a lot of effort [in the project], because it will be nice if [the users] see it all. This database still required a lot of stuff, but I tried to make it as complete as possible. (P5d)

I enjoy what we do in Access a lot, and then I can learn how to do it on my own, and then I can learn to apply it in the test. (P3d)

I now enjoy databases, because we had to do the project, and I learnt a lot of new stuff with the project. (P2d)

All comments linked to extrinsic motivation were made by participant P2d (G = 3). She reported that she would rather do assignments if they counted for marks, and that she would prepare for class if assignments had to be submitted:

I did research for the project, like I searched for an answer, because it counted for marks. I had to do it right. (P2d)

When we had to submit database assignments, I did the preparation. (P2d)

5.2.3 Conclusion of discussion of the qualitative results of the second meso-cycle

In the above section, the qualitative results of MC2 were reported on for each intervention. Factors that hindered transfer, participants' experiences of the implemented guidelines, and qualitative results that can be related to SDL and the categories of the TLO were discussed for each intervention of MC2. In the following section, the quantitative results of MC2 will be reported on.

5.2.4 Reporting on the quantitative results of the second meso-cycle

In this section, the quantitative results of the pre-SRSSDL and the post-SRSSDL and the pre-TLO and the post-TLO will be reported on. At the start of MC2, willing participants answered questions of the pre-SRSSDL and the pre-TLO questionnaires. At the end of MC2, willing participants answered questions of the post-SRSSDL and the post-TLO questionnaires. The results of the pre-SRSSDL and the post-SRSSDL questionnaires will be reported on first, followed by the results of the pre-TLO and the post-TLO questionnaires. Lastly, a comparison of the SRSSDL and the TLO results will be provided.

5.2.4.1 Results of the pre-SRSSDL and the post-SRSSDL in the second meso-cycle

Twenty-six participants (N = 26) completed the pre-SRSSDL questionnaire, and 22 participants (N = 22) completed the post-SRSSDL questionnaire. Demographic information about the

participants was also obtained. The demographic information of the participants that completed the pre-SRSSDL and the post-SRSSDL questionnaires is indicated in Table 5.20.

Table 5.20: Demographics of the participants for the pre-SRSSDL and the post-SRSSDL in the second meso-cycle

Pre-SRSSDL (N = 26)				Post-SRSSDL (N = 22)			
Male	Female	Int/Snr	Snr/FET	Male	Female	Int/Snr	Snr/FET
9	17	9	17	8	14	8	14
Third-year students		Fourth-year students		Third-year students		Fourth-year students	
25		1		21		1	
Age 20 years	Age 21 years	Age ≥ 22 years		Age 20 years	Age 21 years	Age ≥ 22 years	
4	18	4		2	16	4	
Expected %	≤ 40%	41%–50%	51%–60%	61%–70%	71%–80%	≥ 81%	
Pre-SRSSDL	0	0	2	8	12	4	
Post-SRSSDL	2	0	6	8	5	1	

Nine male and 17 female participants (N = 26) completed the pre-SRSSDL, and eight male and 14 female participants (N = 22) completed the post-SRSSDL. Each time, most participants were 21 years old, and four participants were 22 years or older. Participants that were enrolled for the Intermediate and Senior Phase (Int/Snr) programme were studying to become teachers of learners from Grade 5 to Grade 9. Students enrolled in the Senior and Further Education and Training Phase (Snr/FET) programme were studying to become teachers in secondary schools, from Grade 8 to Grade 12. In Table 5.20 the number of students in each programme, the year of their studies, and their expected percentage for the database and network module are also indicated. In the post-SRSSDL, participants' expected percentage dropped. With the pre-SRSSDL, 12 students expected to obtain a percentage between 71% and 80%, and four students expected 81% or more. With the post-SRSSDL only five students expected to obtain a percentage between 71% to 80%, and one student expected to obtain 81% or more.

Table 5.21 shows the descriptive statistics of the pre-SRSSDL and the post-SRSSDL, where 26 participants completed the pre-SRSSDL, and 22 participants completed the post-SRSSDL.

Table 5.21: Descriptive statistics of the pre-SRSSDL and the post-SRSSDL in the second meso-cycle

SRSSDL category	Pre-SRSSDL (N = 26)				Post-SRSSDL (N = 22)			
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD
Awareness	3.67	4.92	4.16	0.31966	2.67	4.75	4.01	0.54062
Learning strategies	3.00	4.33	3.69	0.32895	2.50	4.67	3.70	0.46401
Learning activities	3.25	4.58	3.77	0.32233	3.00	4.50	3.81	0.42037
Evaluation	2.92	4.83	3.70	0.41712	3.00	4.75	3.83	0.50132
Interpersonal skills	2.92	4.92	3.88	0.47439	3.17	4.75	3.96	0.42548
Total score	189.00	278.00	230.46	18.37222	179.00	271.00	231.73	22.96826

Due to the fact that not all participants that completed the pre-SRSSDL completed the post-SRSSDL, the above statistics will not be discussed further. Twenty-one participants (N = 21) completed both the pre-SRSSDL and the post-SRSSDL. In the remainder of this section, the reporting of results will be limited to participants that completed both the pre-SRSSDL and the post-SRSSDL questionnaires. In Table 5.22 the descriptive statistics are shown for the 21 participants that completed both the pre-SRSSDL and the post-SRSSDL.

Table 5.22: Paired-samples statistics for the pre-SRSSDL and the post-SRSSDL in the second meso-cycle

Category	N	Pre-SRSSDL	Post-SRSSDL	Mean difference (post – pre)	Effect size	p-value
Awareness	21	4.1706	3.9960	–0.17460	*–0.54	0.104
Learning strategies	21	3.6905	3.6905	0.00000	0.00	1.000
Learning activities	21	3.7698	3.8175	0.04762	0.17	0.582
Evaluation	21	3.7302	3.8254	0.09524	0.29	0.342
Interpersonal skills	21	3.8810	3.9603	0.07937	0.17	0.322
Total SDL score	21	230.9048	231.4762	0.57143	0.04	0.881

Effect size: * $0.2 < |d| \leq 0.5$ ** $|d| > 0.8$ p-value: * $p < 0.1$

Table 5.22 shows the differences between the means of the pre-SRSSDL and the post-SRSSDL in each of the categories of the SRSSDL. In the awareness category, the mean score decreased with a medium effect ($d = 0.54$). The mean score in the evaluation category improved with a small effect ($d = 0.29$). An improvement in the average score is also noted in the categories “learning activities” ($d = 0.17$) and “interpersonal skills” ($d = 0.17$) and in the total SDL score ($d = 0.04$), however without meaningful effect sizes.

To obtain more insight into the results, the participants were divided into moderate and high SDL groups. No participants rated themselves in the low SDL group. Figure 5.24 compares the number of participants in the moderate and the high SDL groups in the pre-SRSSDL and the post-SRSSDL. In the pre-SRSSDL, three participants rated themselves in the moderate SDL group, and in the post-SRSSDL six participants rated themselves in the moderate SRSSDL group. Eighteen participants rated themselves in the high SDL group in the pre-SRSSDL, and 15 participants rated themselves in the high SDL group in the post-SRSSDL.

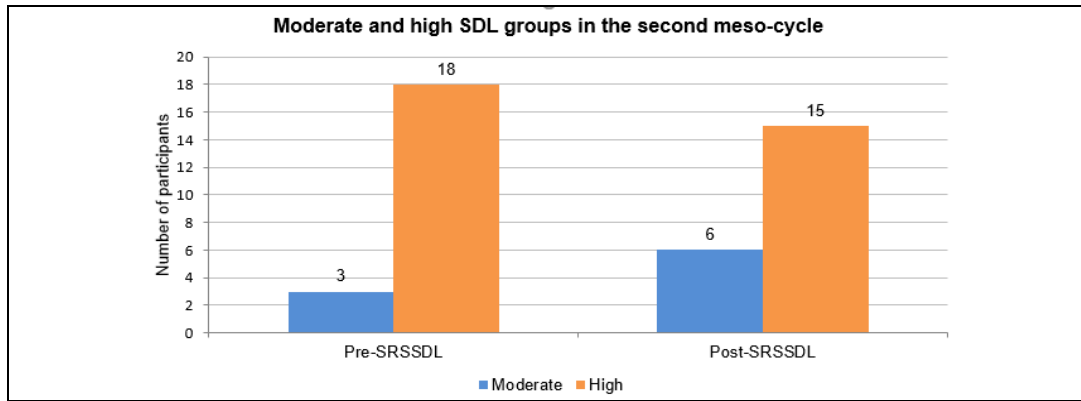


Figure 5.24: Moderate and high SDL groups in the second meso-cycle

Table 5.23 shows the results of the paired-samples statistics of the pre-SRSSDL and the post-SRSSDL of MC2 according to the moderate and the high SDL groups.

Table 5.23: Paired-samples statistics for the moderate and the high SDL groups in the second meso-cycle

SRSSDL category	Moderate SDL (N = 3)				High SDL (N = 18)			
	Mean	Mean difference	Effect size	p-value	Mean	Mean difference	Effect size	p-value
Awareness (pre)	3.7778	-0.36111	**-1.88	0.213	4.2361	-0.14352	*-0.49	0.229
Awareness (post)	3.4167				4.0926			
Learning strategies (pre)	3.1667	-0.11111	*-0.50	0.635	3.7778	0.01852	0.07	0.749
Learning strategies (post)	3.0556				3.7963			
Learning activities (pre)	3.3333	-0.16667	**-1.15	*0.074	3.8426	0.08333	*0.38	0.401
Learning activities (post)	3.1667				3.9259			
Evaluation (pre)	3.2778	0.02778	0.09	0.893	3.8056	0.10648	*0.39	0.353
Evaluation (post)	3.3056				3.9120			
Interpersonal skills (pre)	3.4167	0.11111	0.25	0.635	3.9583	0.07407	0.18	0.407
Interpersonal skills (post)	3.5278				4.0324			
Total SDL score (pre)	203.667	-6.00000	*-0.47	0.188	235.444	1.66667	0.15	0.705
Total SDL score (post)	197.667				237.111			

Effect size: *0.2 < |d| ≤ 0.5 **|d| > 0.8 p-value: *p < 0.1

In the moderate SDL group (see Table 5.23), the mean scores for the categories “awareness” ($d = 1.88$) and “learning activities” ($d = 1.15$) both decreased with a large effect. The mean score of the learning strategies ($d = 0.50$) category decreased with a medium effect. An improvement is noticed in the evaluation category ($d = 0.09$), but without a notable effect size. The mean score of the interpersonal skills category ($d = 0.25$) improved with a medium effect. The total SDL

score of the moderate SDL group decreased with a medium effect ($d = 0.47$). It should be noted that the number of participants in this category is only three, which is not ideal for calculating statistics.

All categories of the high SDL group improved, except for the awareness category, which decreased with a medium effect ($d = 0.49$). The categories “learning activities” ($d = 0.38$) and “evaluation” ($d = 0.39$) improved with a medium effect. An improvement is noticed in the interpersonal skills category, but with a small effect ($d = 0.18$). The total SDL score of the high SDL group improved, but also with a small effect ($d = 0.15$).

Because of the small number of participants ($N = 21$), the results of the pre-SRSSDL and the post-SRSSDL will also be analysed for each participant, so as to obtain more insight into the results. Table 5.24 shows the individual scores for each participant for each of the SRSSDL categories. The scores of participants P1 to P6 were in the moderate SDL category after the post-SRSSDL. It should be noted that the numbering of participants (“P1”, “P2”, etc.) is not according to the numbering that was used when the qualitative results were reported on, because all participants did not participate in all data collection activities. Table 5.24 also shows the number of mean scores, as well as the number of total SDL scores that increased, decreased or stayed the same in each category from the pre-SRSSDL to the post-SRSSDL. The movement in scores from the pre-SRSSDL to the post-SRSSDL is depicted in Figure 5.25.

Table 5.24: Pre-SRSSDL and post-SRSSDL scores for each participant in the second meso-cycle

Participant	Awareness			Learning strategies			Learning activities			Evaluation			Interpersonal skills			Total		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
P1	3.67	2.92	-0.75	3.00	2.50	-0.50	3.25	3.00	-0.25	2.92	3.08	0.16	2.92	3.42	0.50	189	179	-10
P2	4.00	2.67	-1.33	3.58	3.17	-0.41	3.83	3.17	-0.66	3.67	3.50	-0.17	3.75	3.17	-0.58	226	188	-38
P3	3.67	3.42	-0.25	3.42	3.42	0.00	3.50	3.42	-0.08	3.50	3.17	-0.33	3.58	3.58	0.00	212	204	-8
P4	4.42	3.33	-1.09	3.58	3.67	0.09	3.83	3.42	-0.41	3.83	3.25	-0.58	3.92	3.33	-0.59	235	204	-31
P5	4.00	3.92	-0.08	3.08	3.25	0.17	3.25	3.08	-0.17	3.42	3.67	0.25	3.75	3.58	-0.17	210	210	0
P6	4.42	3.58	-0.84	3.92	3.67	-0.25	3.58	3.42	-0.16	3.75	3.00	-0.75	4.75	4.08	-0.67	245	213	-32
P7	4.00	4.08	0.08	3.58	3.75	0.17	4.00	4.08	0.08	3.17	3.50	0.33	3.75	3.75	0.00	222	230	8
P8	3.83	3.92	0.09	3.67	3.67	0.00	3.83	3.92	0.09	3.75	3.58	-0.17	4.33	4.25	-0.08	233	232	-1
P9	4.25	4.08	-0.17	3.67	3.83	0.16	4.00	3.92	-0.08	3.75	4.00	0.25	3.33	3.67	0.34	228	234	6
P10	4.42	4.50	0.08	3.67	3.42	-0.25	4.42	3.67	-0.75	3.75	4.25	0.50	3.42	3.83	0.41	236	236	0
P11	4.33	4.33	0.00	3.83	3.75	-0.08	3.67	4.25	0.58	3.67	3.25	-0.42	4.17	4.33	0.16	236	239	3
P12	4.25	4.33	0.08	3.42	3.42	0.00	3.75	3.92	0.17	4.17	3.92	-0.25	4.00	4.33	0.33	235	239	4
P13	3.83	4.00	0.17	3.92	4.17	0.25	3.92	4.08	0.16	4.00	3.92	-0.08	3.83	3.75	-0.08	234	239	5
P14	4.08	4.08	0.00	3.58	3.92	0.34	3.67	4.17	0.50	3.67	4.08	0.41	3.50	3.83	0.33	222	241	19
P15	4.25	3.83	-0.42	4.33	4.25	-0.08	4.00	3.83	-0.17	4.17	4.17	0.00	4.08	4.25	0.17	250	244	-6
P16	4.42	4.50	0.08	3.67	3.33	-0.34	3.58	4.17	0.59	3.75	4.75	1.00	3.58	3.83	0.25	228	247	19
P17	3.67	4.17	0.50	3.67	4.08	0.41	3.83	4.08	0.25	3.92	3.92	0.00	4.58	4.50	-0.08	236	249	13
P18	4.33	4.75	0.42	3.50	3.33	-0.17	3.83	4.50	0.67	3.67	4.50	0.83	3.58	3.92	0.34	227	252	25
P19	4.33	4.42	0.09	3.83	4.00	0.17	3.58	4.00	0.42	3.58	4.25	0.67	3.75	4.42	0.67	229	253	24
P20	4.50	4.42	-0.08	4.33	4.67	0.34	3.67	3.67	0.00	3.83	3.92	0.09	4.50	4.75	0.25	250	257	7
P21	4.92	4.67	-0.25	4.25	4.25	0.00	4.17	4.42	0.25	4.42	4.67	0.25	4.42	4.58	0.16	266	271	5
No. +		9		9			11			11			12			12		
No. -		10		8			9			8			7			7		
Same		2		4			1			2			2			2		

Figure 5.25 depicts the scores for each participant for each category of the SRSSDL, as summarised in Table 5.24 above.

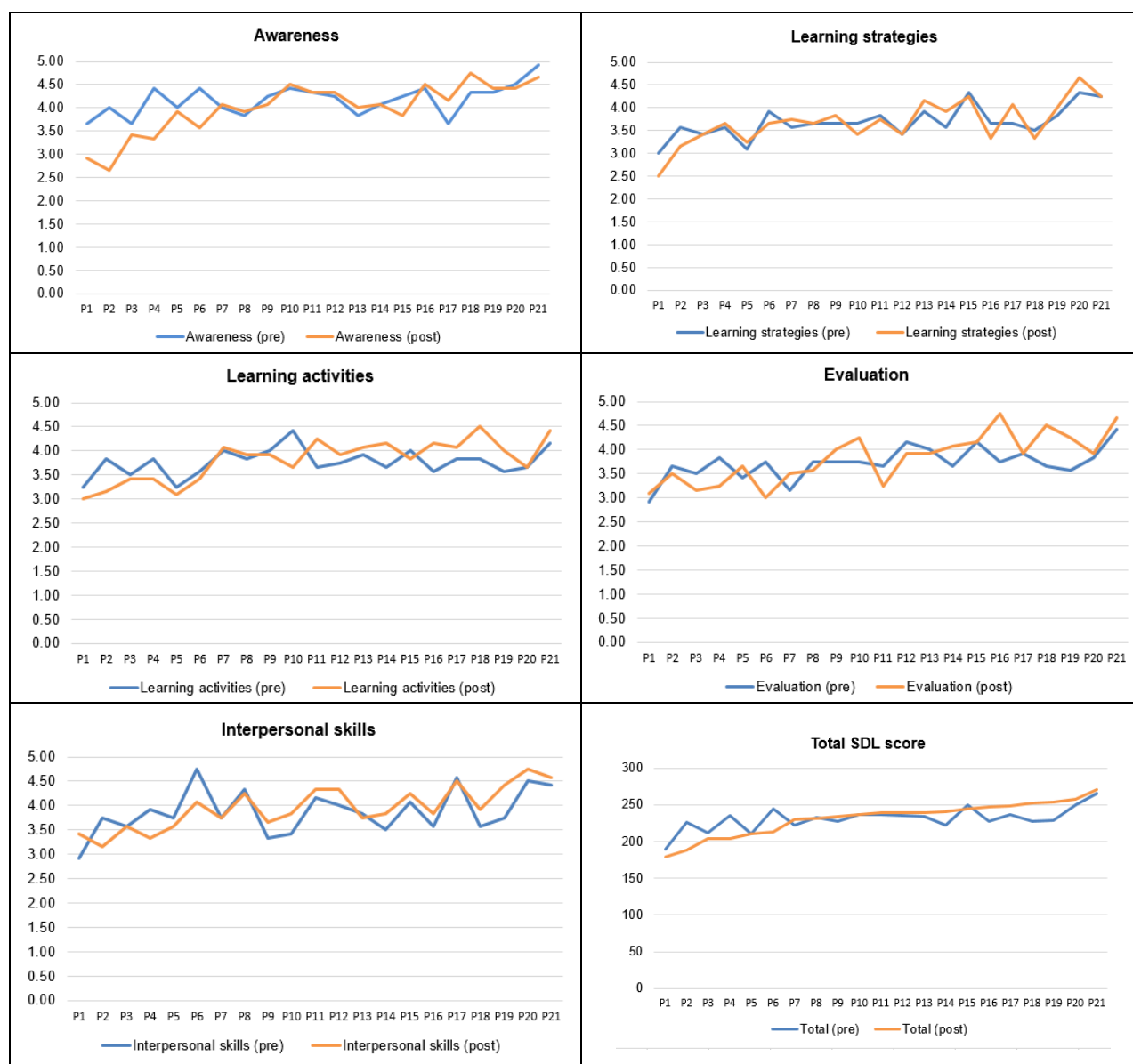


Figure 5.25: Movement in SDL scores in the second meso-cycle

In this section, the descriptive statistics and paired-samples statistics of the pre-SRSSDL and the post-SRSSDL of MC2 were reported on. The paired-samples statistics were also reported on for the moderate and the high SDL categories. The pre-SRSSDL and the post-SRSSDL scores of each participant were also indicated. In the following section the results of the TLO of MC2 will be discussed.

5.2.4.2 Results of the pre-TLO and the post-TLO tool in the second meso-cycle

Twenty-six (N = 26) participants completed the pre-TLO in MC2. After calculating the inferential statistics, it was found that the self-motivation category indicated poor reliability ($\alpha = 0.197$), and questions 1 and 5 were omitted from the self-motivation category. After omitting questions 1 and

5, the Cronbach's alpha improved to 0.824. When analysing the data, however, it seemed that questions 1 and 5 of the self-motivation category worked against questions 2 and 3. Questions 1 and 5 indicated intrinsic motivation, while questions 2 and 3 indicated extrinsic motivation. The extrinsic motivation category was thus coded in reverse.

As students may have personal factors in their own individual contexts that motivate their learning, for example not wanting to let their families down, we did not want to exclude data obtained from questions 1 and 5 merely because of reliability factors. An additional scale to indicate extrinsic motivation was therefore added, which was determined by the average of questions 2 and 3 (still coded in reverse). The original scale of self-motivation was thus relabelled "self-motivated_int" (intrinsic motivation), indicating the mean of questions 1 and 5 (see Table 5.25). The additional category was labelled "self-motivation_ext" (extrinsic motivation), indicating the mean scores of questions 2 and 3.

The learning belief category also had poor reliability, and question 8 had to be omitted. All other categories of the TLO had acceptable reliabilities. Table 5.25 indicates the reliability of the categories of the adjusted TLO. The questions included in each category are shown, as well as the questions that had to be omitted due to reliability issues.

Table 5.25: Reliability of the TLO in the second meso-cycle

Category	Cronbach's alpha (α)	Questions included	Questions omitted
Self-motivated_int	0.526	Q1, Q5	
Self-motivated_ext	0.824	Q2, Q3	
Learning belief	0.537	Q6, Q7, Q9, Q11	Q8
Self-efficacy	0.826	Q12(r), Q13, Q14, Q15, Q17	
Transfer	0.735	Q18, Q19, Q20, Q22	
Organisation	0.600	Q23, Q24, Q25(r), Q26, Q28	

Because questions 2 and 3 of the TLO were coded in reverse, a low mean for "self-motivated extrinsically" indicated that participants were highly motivated by extrinsic factors. Figure 5.26 shows an example of a spider diagram drawn from one participant's pre-TLO results, including the intrinsic motivation and the extrinsic motivation scales of the TLO. The range of the scales is from 0 to 4. The score for intrinsic motivation is not high, at 2.5. The score for extrinsic motivation is 0.5, which indicates that the participant is highly motivated by extrinsic factors. This participant feels confident about their studies (confident = 3.8) and views themselves as a flexible learner (flexible learner = 3.5). The mean score for the "makes connections" category is 2.75, and the participant did not have a high learning belief (learns independently = 2.5). Spider diagrams for the pre-TLO and the post-TLO will be discussed further in section 5.2.4.2.2.

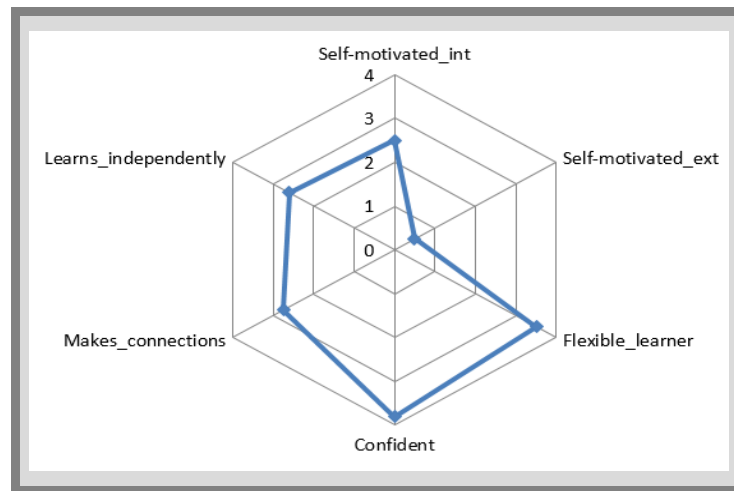


Figure 5.26: Example of a spider diagram with adjusted TLO categories

5.2.4.2.1 Descriptive statistics of the pre-TLO and the post-TLO in the second meso-cycle

Table 5.26 shows the descriptive statistics of the pre-TLO and the post-TLO questionnaires as obtained in MC2. Twenty-six participants (N = 26) completed the pre-TLO questionnaire, and 25 participants completed the post-TLO questionnaire (N = 25). Based on the low mean score of 0.3846 and the standard deviation of 0.55331 on the extrinsic motivation scale of the pre-TLO, the group of participants can be described as highly extrinsically motivated at the start of the semester. A maximum value of only 2.0 was reported for the extrinsic motivation scale. No participant scored higher than 3.0 on the intrinsic motivation scale, and the average was only 2.1538. The category with the highest average in the pre-TLO was for the flexible learner category, with a mean score of 2.9231.

Table 5.26: Descriptive statistics of the pre-TLO and the post-TLO results in the second meso-cycle

TLO category	Pre-TLO results (N = 26)				Post-TLO results (N = 25)			
	Mini- mum	Maxi- mum	Mean	SD	Mini- mum	Maxi- mum	Mean	SD
Self-motivated_int	0.50	3.00	2.1538	0.67482	1.50	3.50	2.5000	0.59512
Self-motivated_ext	0.00	2.00	0.3846	0.55331	0.00	2.50	0.6800	0.61033
Flexible learner	1.75	3.75	2.9231	0.51850	2.00	4.00	3.0500	0.60381
Confident	1.60	3.80	2.8615	0.61908	1.60	4.00	2.8800	0.64550
Makes connections	0.00	3.25	2.4423	0.70819	1.00	4.00	2.7400	0.63114
Learns independently	1.00	3.80	2.3615	0.63250	1.20	3.60	2.5200	0.56569

Twenty-four (N = 24) participants completed both the pre-TLO and the post-TLO questionnaires. In the remainder of this section, only the results of participants that completed both the pre-TLO and the post-TLO will be reported on.

Table 5.27 displays the results of the paired-samples statistics of participants that completed both the pre-TLO and the post-TLO (N = 24). It is evident that for MC2, all categories improved from the pre-TLO to the post-TLO.

Table 5.27: Paired-samples statistics of the TLO in the second meso-cycle

TLO category	N	Mean (pre-TLO)	Mean (post-TLO)	Mean difference (post – pre)	Effect size (<i>d</i>)	<i>p</i> -value
Self-motivated_int	24	2.2917	2.4792	0.1875	0.38*	0.233
Self-motivated_ext	24	0.3958	0.6875	0.2917	0.51*	0.045*
Flexible learner	24	2.9375	3.0938	0.1563	0.32*	0.226
Confident	24	2.8750	2.9000	0.0250	0.04	0.828
Makes connections	24	2.5000	2.7292	0.2292	0.33*	0.046*
Learns independently	24	2.4167	2.5167	0.1000	0.16	0.347

Effect size: * $0.2 < |d| \leq 0.5$ ** $|d| > 0.8$ *p*-value: * $p < 0.1$

The categories “self-motivated_int” ($d = 0.38$), “self-motivation_ext” ($d = 0.51$), “flexible learner” ($d = 0.32$) and “makes connections” ($d = 0.33$) all improved with a medium effect. These results indicate the possibility that participants were inclined to transfer knowledge and were less motivated by extrinsic factors. The categories “confident” ($d = 0.04$) and “learns independently” ($d = 0.16$) also improved, but with too small effect.

Figure 5.27 depicts the improvements in the various categories of the TLO.

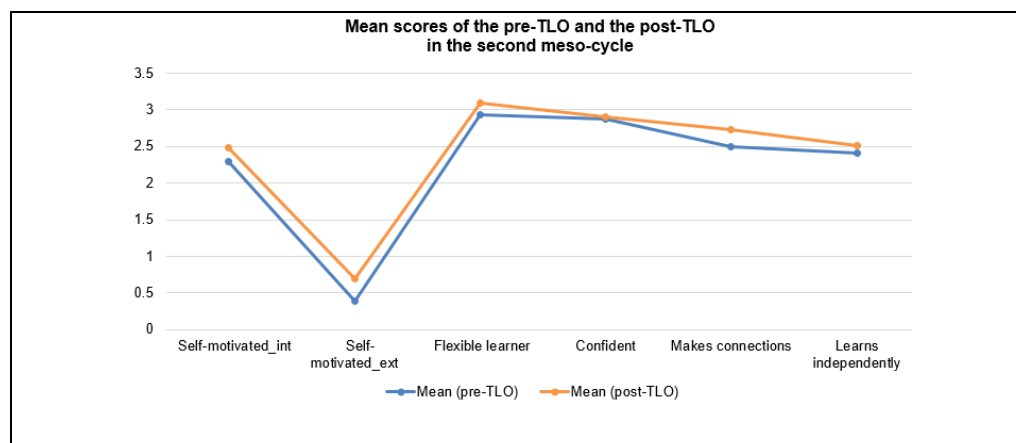


Figure 5.27: Mean scores of the pre-TLO and the post-TLO in the second meso-cycle

To obtain more insight into the results of the TLO, the scores for each participant for each category will be reported on next. Table 5.28 indicates the individual mean scores for each category of each participant that completed both the pre-TLO and the post-TLO. Table 5.28 further indicates the differences between the average scores of the pre-TLO and the post-TLO for each participant for each category. In Table 5.28, “No. +” indicates the total number of mean scores in each category that improved, and “No. –” indicates the total number of mean scores in

the category that decreased. The total number of average scores in each category that stayed the same is also indicated.

Table 5.28: Individual mean scores for each participant for each category of the pre-TLO and the post-TLO in the second meso-cycle

Participant	Self-motivated_int			Self-motivated_ext			Flexible learner			Confident			Makes connections			Learns independently		
	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
P1	1.5	3.0	1.5	1.5	1.0	-0.5	3.0	3.0	0.0	2.6	3.2	0.6	1.8	2.3	0.5	2.2	2.6	0.4
P2	2.0	2.5	0.5	0.0	0.5	0.5	2.0	2.3	0.3	2.0	2.4	0.4	2.5	2.8	0.3	2.6	3.4	0.8
P3	2.0	2.0	0.0	0.0	0.5	0.5	1.8	2.8	1.0	2.6	3.2	0.6	0.0	1.0	1.0	2.0	2.2	0.2
P4	2.0	2.0	0.0	0.0	0.0	0.0	2.5	2.5	0.0	2.2	1.8	-0.4	2.0	2.0	0.0	1.4	1.8	0.4
P5	2.5	3.0	0.5	0.0	1.0	1.0	3.5	2.3	-1.3	2.6	2.0	-0.6	2.0	2.8	0.8	1.4	2.0	0.6
P6	2.5	2.0	-0.5	1.0	1.5	0.5	3.0	3.5	0.5	2.8	2.6	-0.2	2.5	2.8	0.3	2.8	2.6	-0.2
P7	3.0	3.0	0.0	0.0	0.5	0.5	2.5	3.3	0.8	3.6	3.2	-0.4	3.0	3.3	0.3	2.8	2.4	-0.4
P8	1.5	2.0	0.5	0.5	1.0	0.5	2.5	2.8	0.3	1.6	1.8	0.2	3.0	2.8	-0.3	1.0	1.2	0.2
P9	3.0	3.0	0.0	0.0	2.5	2.5	3.0	4.0	1.0	3.8	4.0	0.2	3.3	3.3	0.0	2.0	3.4	1.4
P10	2.0	3.0	1.0	1.0	0.5	-0.5	2.8	2.3	-0.5	2.4	2.6	0.2	2.3	2.0	-0.3	2.4	2.2	-0.2
P11	3.0	2.5	-0.5	1.0	0.5	-0.5	3.8	2.8	-1.0	3.6	3.2	-0.4	3.0	3.3	0.3	1.6	2.0	0.4
P12	2.0	3.0	1.0	0.0	0.0	0.0	3.0	3.5	0.5	3.0	3.0	0.0	3.0	3.0	0.0	2.4	2.0	-0.4
P13	2.5	3.5	1.0	0.0	0.0	0.0	2.5	3.8	1.3	2.4	3.4	1.0	2.5	3.8	1.3	3.2	3.0	-0.2
P14	3.0	2.0	-1.0	0.0	1.0	1.0	3.3	3.3	0.0	2.2	3.0	0.8	3.3	3.0	-0.3	2.8	2.8	0.0
P15	1.5	2.5	1.0	2.0	1.5	-0.5	2.8	2.5	-0.3	2.6	2.6	0.0	2.3	2.3	0.0	2.4	2.6	0.2
P16	2.0	2.5	0.5	0.0	0.0	0.0	3.3	3.3	0.0	3.0	3.8	0.8	2.0	3.3	1.3	2.8	2.6	-0.2
P17	2.5	3.5	1.0	0.0	0.5	0.5	3.8	4.0	0.3	3.8	4.0	0.2	3.0	4.0	1.0	2.8	3.6	0.8
P18	2.5	3.0	0.5	0.5	0.0	-0.5	3.5	3.8	0.3	3.8	3.4	-0.4	2.8	2.5	-0.3	2.6	2.6	0.0
P19	2.0	2.0	0.0	0.0	0.0	0.0	3.0	3.5	0.5	3.0	3.2	0.2	2.8	2.0	-0.8	2.8	2.8	0.0
P20	2.5	1.5	-1.0	0.5	1.0	0.5	2.8	2.5	-0.3	2.8	1.6	-1.2	3.0	3.0	0.0	2.2	1.6	-0.6
P21	2.0	2.5	0.5	0.0	1.0	1.0	3.3	3.5	0.3	2.4	2.8	0.4	2.0	2.5	0.5	2.8	2.8	0.0
P22	3.0	1.5	-1.5	0.5	1.0	0.5	3.0	3.8	0.8	3.6	3.2	-0.4	3.0	2.5	-0.5	3.8	2.8	-1.0
P23	2.0	1.5	-0.5	1.0	1.0	0.0	3.0	3.3	0.3	2.8	2.8	0.0	2.8	3.3	0.5	2.6	2.4	-0.2
P24	2.5	2.5	0.0	0.0	0.0	0.0	3.3	2.5	-0.8	3.8	2.8	-1.0	2.5	2.5	0.0	2.6	3.0	0.4
	No. -		6	No. -		5	No. -		6	No. -		9	No. -		6	No. -		9
	No. +		12	No. +		12	No. +		14	No. +		12	No. +		12	No. +		11
	Same		6	Same		7	Same		4	Same		3	Same		6	Same		4

In all categories, the number of participants whose scores improved exceeded the number of participants whose scores decreased. The individual scores for each participant for each category are depicted in Figure 5.28.



Figure 5.28: Individual mean scores for each participant for each category of the TLO in the second meso-cycle

In this section, the descriptive statistics for the pre-TLO and the post-TLO of MC2 were reported on. In the following section, spider diagrams of some individual results of the pre-TLO and the post-TLO will be discussed.

5.2.4.2.2 Spider diagrams drawn from the TLO results in the second meso-cycle

The spider diagrams obtained from the results of MC2 depict an additional category, namely “self-motivated_ext”, to those of the diagrams of MC1 (see section 5.1.4.2.2), as explained in section 5.2.4.2. Because the “self-motivated extrinsically” category was coded in reverse, a low

score in this category would thus indicate that the participant is highly motivated by extrinsic factors.

In Table 5.29, spider diagrams of the results of individual participants, as indicated in Table 5.28 are given. With each spider diagram, quotes are provided to clarify the averages of each category. The quotes were obtained from the open-ended questions of the TLO (see Table 5.11) and from one-on-one interviews where possible, to determine whether the mean scores of the TLO categories can be qualitatively confirmed. With each spider diagram, the number assigned to the participant (see Table 5.28) and the percentages obtained in the two transfer tests (TT1 and TT2) are indicated. These assigned numbers do not, however, correspond to the numbers assigned to participants in the interviews, as participants did not participate in all data collection activities.

The first diagram in Table 5.29 depicts the results of participant P15, who obtained 60% for the first transfer test (after the first intervention) and 66% for the second transfer test (after the second intervention). In the diagram it can be observed that the score for the “self-motivated intrinsically” category improved, and that the score for the “self-motivated extrinsically” category decreased. Although the participant was thus more intrinsically motivated, they were also motivated by extrinsic factors.

Participant P3 (see Table 5.29) obtained 38% for the first transfer test, and 70% for the second transfer test. Improvements are noticed in most categories. Although participant P3’s score for intrinsic motivation seemed to stay the same, her extrinsic motivation improved (the extrinsic motivation category was coded in reverse). Participant P3 can thus be described as being less motivated by extrinsic factors after the second intervention.

In the spider diagram of participant P9 (see Table 5.29), a rounder shape is noticed after the second intervention, although her percentage for the second transfer test dropped to 74%. According to Simper *et al.* (2016:1170), the rounder shape of the spider diagram indicates that participant P9 is more balanced in the various categories, and that she has thus addressed her initial self-reported weaknesses. The extrinsic motivation category also shows considerable improvement, which indicates that participant P9 is now much less motivated by extrinsic factors after the second intervention.

Table 5.29: Spider diagrams from the pre-TLO and the post-TLO results in the second meso-cycle

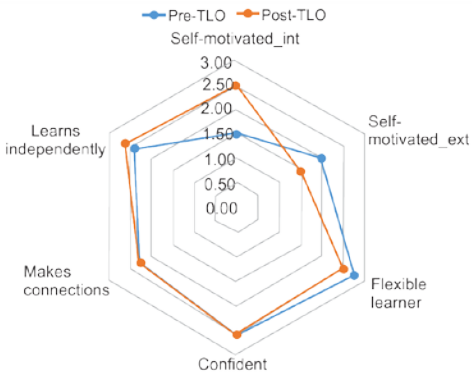
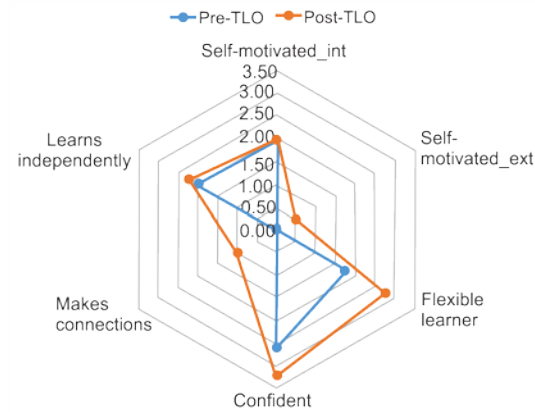
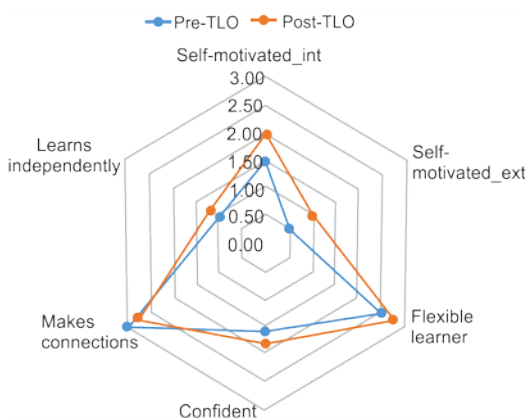
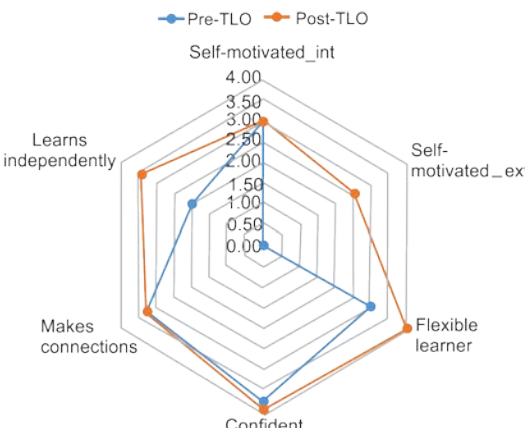
P15: 60% (TT1); 66% (TT2)	
 Legend: Pre-TLO (blue line), Post-TLO (orange line) Categories: Self-motivated_int, Self-motivated_ext, Flexible learner, Confident, Makes connections, Learns independently	Learning belief / flexible learner: <i>Planning, set out the work in sequence, organise everything exactly. (pre)</i> <i>I managed my time. (post)</i>
	Confident / self-efficacy: <i>Lack confidence in time management, how information will be passed on, and if I will understand or not. (pre)</i> <i>The work that I don't understand well can let me down. (post)</i>
	Transfer / makes connections: <i>Repetition, learn from memory. (pre)</i> <i>Planning and time management. (post)</i>
	Learns independently: <i>Being organised and having goals is very important. (pre)</i> <i>I planned and managed my time, to learn in full and set things out my way. (post)</i>
Self-motivated_int: <i>The idea that I'll learn something new each time. (pre)</i> <i>The way in which new work is learnt. (post)</i>	Self-motivated_ext: No quotes for this category.
P3: 38% (TT1); 70% (TT2)	
 Legend: Pre-TLO (blue line), Post-TLO (orange line) Categories: Self-motivated_int, Self-motivated_ext, Flexible learner, Confident, Makes connections, Learns independently	Learning belief / flexible learner: <i>I have control over extrinsic factors that can influence my academic performance. (pre)</i> <i>I believe one doesn't have control over everything. Some days emotions are high, and thoughts wander. (post)</i>
	Confident / self-efficacy: <i>The module is very challenging. It's different and difficult, because I didn't have CAT at school. (pre)</i> <i>Self-discipline, and one must work for what you're looking for. This was by far the most difficult module I had in CAT. I had no prior knowledge. (post)</i>
	Transfer / makes connections: <i>I work hard and try to keep up to date. I try to learn by discovering new information. (pre)</i> <i>A lot of problem-solving took place in this module. A lot of self-learning takes place, which forces you to pay attention and make your own connections. (post)</i>
Self-motivated_int: No quotes for this category.	Self-motivated_ext: <i>To get an academic bursary and take the pressure off my mother. (pre)</i> <i>Good results, and because I failed the first test. (post)</i>
Learns independently: <i>I take it day by day and try not to make it too difficult. (pre)</i> <i>I propose that more clarity be given in terms of what's expected and on what's going on in the module. (post)</i>	

Table 5.29: Spider diagrams from the pre-TLO and the post-TLO results in the second meso-cycle (continued)

P8: 62% (TT1); 34% (TT2)		
	Learning belief / flexible learner: <i>I am fairly in control of the learning. Other factors, such as the noise in the hostel, cause trouble. (pre)</i> <i>I had learning obstacles at home, noise, number of tasks in all subjects, obstacles in focusing and being disciplined. (post)</i>	
	Confident / self-efficacy: <i>Lack of confidence in networks and creating macros. (pre)</i> <i>Lack of confidence in some parts of Access. (post)</i>	
	Transfer / makes connections: <i>I applied problem-solving when doing tasks and practical teaching in schools. (pre)</i> <i>Learning and doing problem-solving in groups. (post)</i>	
Self-motivated_int: <i>I am motivated by computer skills. (pre)</i> <i>A heavy workload, but interesting. (post)</i>	Self-motivated_ext: <i>I need to obtain my degree. (pre)</i> <i>I need to finish my degree. (post)</i>	Learns independently: <i>I planned tasks according to due dates. (pre)</i> <i>Made notes and used checklists. (post)</i>
P9: 87% (TT1); 74% (TT2)		
	Flexible learner / learning belief: <i>I mostly have control over different factors in my life. (pre)</i> <i>I definitely improved my time management. The more time I allocate to a task, the better I understand the work. (post)</i>	
	Confident / self-efficacy: <i>I have enough self-confidence to know that I can attempt anything in this module. (pre)</i> <i>Networks are difficult, but I know if I do my part, then I'll understand and enjoy them. (post)</i>	
	Transfer / makes connections: <i>I created questions and problem scenarios for myself and tried to solve them. (pre)</i> <i>I tried to let each module connect to other modules. It made sense to me if everything fitted together. (post)</i>	
Self-motivated_int: <i>I love this subject. I find it extremely nice. (pre)</i> <i>I enjoyed it a lot and found it very informative. (post)</i>	Self-motivated_ext: <i>One day I would like to be a successful CAT teacher. (post)</i>	
Learns independently: <i>I set goals for myself and did my best to reach them. (pre)</i> <i>I made sure I had enough time to complete an assignment, and then I understood the work better and could work thoroughly through each question. (post)</i>		

5.2.4.3 Results of the TLO compared with results of the SRSSDL in the second meso-cycle

To obtain further insight into all the quantitative results, the results of the pre-TLO and the post-TLO and the results of the pre-SRSSDL and the post-SRSSDL were compared. The results of the pre-SRSSDL and the post-SRSSDL were split into moderate and high SDL groups. These results were then each time compared with the pre-TLO and the post-TLO results, to determine how participants in each SDL group scored on the TLO (see Table 5.30). A paired-samples test was each time done to statistically compare the means of the various categories in the moderate and the high SDL groups. Thereafter, a Spearman's rho correlation was also done on the results of the TLO and the SRSSDL in the moderate and the high SDL groups (see Table 5.31 and Table 5.32). These results will now be reported on.

Table 5.30: Paired-samples statistics for the TLO for the moderate and the high SDL groups in the second meso-cycle

SDL group	TLO category	Mean pre-TLO	Mean post-TLO	Mean difference	Effect size	p-value
Moderate SDL (N = 4)	Self-motivated_int	1.8750	2.3750	0.5000	2.00*	0.252
	Self-motivated_ext	0.3750	0.5000	0.1250	0.17	0.638
	Flexible learner	2.3125	2.6250	0.3125	0.56*	0.278
	Confident	2.3500	2.6500	0.3000	1.00*	0.297
	Makes connections	1.5625	2.0000	0.4375	0.40*	0.133
	Learns independently	2.0500	2.5000	0.4500	0.90**	0.037*
High SDL (N = 20)	Self-motivated_int	2.3750	2.5000	0.1250	0.26	0.470
	Self-motivated_ext	0.4000	0.7250	0.3250	0.59*	0.055*
	Flexible learner	3.0625	3.1875	0.1250	0.33*	0.398
	Confident	2.9800	2.9500	-0.0300	-0.05	0.815
	Makes connections	2.6875	2.8750	0.1875	0.45*	0.143
	Learns independently	2.4900	2.5200	0.0300	0.05	0.801

Effect size: $0.2 < |d| \leq 0.5$ $**|d| > 0.8$ p-value: $*p < 0.1$

Table 5.30 indicates the differences in the mean scores of the various categories of the pre-TLO and the post-TLO, and the pre-SRSSDL and the post-SRSSDL in the moderate SDL and the high SDL groups. In the moderate SDL group, improvement in all categories of the TLO is noticed. The TLO category “learns independently” improved with a large effect size ($d = 0.9$). The categories “self-motivated_int” ($d = 2.0$) and “confident” ($d = 1.0$) also both improved with large effect sizes. The categories “flexible learner” ($d = 0.56$) and “makes connections” ($d = 0.40$) both improved with a medium-sized effect.

In the high SDL group, all categories except the “confident” category improved. The “confident” category, however, decreased with no notable effect size ($d = 0.05$). The categories “flexible learner” ($d = 0.33$), “makes connections” ($d = 0.45$) and “self-motivated_ext” ($d = 0.59$) improved with a medium-sized effect. It is thus possible that participants in the high SDL group were less motivated by extrinsic factors and were more inclined to transfer their knowledge.

A Spearman’s rho correlation was done on results of the TLO and the SRSSDL. The results indicate correlations between some categories of the TLO and the SRSSDL (see Table 5.31 and Table 5.32). As mentioned by Mertler (2016:277), correlation between categories “does not imply causation”, and further investigation of these correlations is thus required. Table 5.31 indicates the correlations for the pre-TLO and the pre-SRSSDL. Twenty-six participants ($N = 26$) completed both the pre-TLO and the pre-SRSSDL questionnaires.

Table 5.31: Correlations between the categories of the pre-TLO and the pre-SRSSDL in the second meso-cycle

Pre-TLO categories	N = 26	Pre-SRSSDL categories					
		Aware-ness	Learning strategies	Learning activities	Evaluation	Interpersonal skills	Total SDL
Self-motivated_int	Correlation coefficient	0.750**	0.490*	0.359	0.383	0.247	0.550**
	Sig. (2-tailed)	0.000	0.011	0.072	0.053	0.225	0.004
Self-motivated_ext	Correlation coefficient	-0.150	-0.087	0.054	-0.018	0.030	-0.028
	Sig. (2-tailed)	0.465	0.672	0.793	0.929	0.884	0.892
Flexible learner	Correlation coefficient	0.364	0.381	0.407*	0.517**	0.331	0.496**
	Sig. (2-tailed)	0.068	0.055	0.039	0.007	0.098	0.010
Confident	Correlation coefficient	0.472*	0.366	0.275	0.355	0.258	0.384
	Sig. (2-tailed)	0.015	0.066	0.174	0.075	0.203	0.053
Makes connections	Correlation coefficient	0.632**	0.608**	0.714**	0.557**	0.487*	0.780**
	Sig. (2-tailed)	0.001	0.001	0.000	0.003	0.012	0.000
Learns independently	Correlation coefficient	0.559**	0.264	0.299	0.187	-0.100	0.272
	Sig. (2-tailed)	0.003	0.192	0.138	0.360	0.627	0.179

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

The “intrinsic self-motivation” category of the TLO correlates with the “awareness” ($r_s = 0.750$) and “learning strategies” ($r_s = 0.490$) categories and the total SDL score ($r_s = 0.550$). The “flexible learner” category correlates with the “learning activities” ($r_s = 0.407$) and “evaluation” ($r_s = 0.517$) categories and the total SDL score ($r_s = 0.496$). The “confident” ($r_s = 0.472$) and “learns independently” ($r_s = 0.559$) categories of the TLO only correlated with the “awareness” category of the SRSSDL. The “makes connections” category correlates with all categories of the

SRSSDL, as well as with the total SDL score ($r_s = 0.780$). No correlations were observed between the “extrinsically self-motivated” category and categories of the SRSSDL.

The categories of the post-TLO and the post-SRSSDL did not all correlate on the same categories as the pre-TLO and the pre-SRSSDL (see Table 5.32). Twenty participants completed both the post-TLO and the post-SRSSDL. According to Table 5.32, the “awareness” category in the SRSSDL correlates with the categories “flexible learner” ($r_s = 0.576$), “confident” ($r_s = 0.450$), “makes connections” ($r_s = 0.477$) and “learns independently” ($r_s = 0.568$) of the TLO. Correlations of the TLO category “flexible learner” are further noticed with the “interpersonal skills” ($r_s = 0.563$) category and the total SDL score ($r_s = 0.551$). The “evaluation” category of the SRSSDL also correlates with the “makes connections” category ($r_s = 0.486$) of the TLO.

Table 5.32: Correlations between categories of the post-TLO and the post-SRSSDL in the second meso-cycle

Post-TLO categories	N = 20	Post-SRSSDL categories					
		Aware-ness	Learning strategies	Learning activities	Evaluation	Inter-personal skills	Total SDL
Self-motivated_int	Correlation coefficient	0.153	0.036	0.269	0.327	0.116	0.240
	Sig. (2-tailed)	0.520	0.881	0.251	0.160	0.627	0.307
Self-motivated_ext	Correlation coefficient	-0.104	-0.014	-0.177	-0.214	-0.081	-0.231
	Sig. (2-tailed)	0.663	0.954	0.456	0.365	0.735	0.328
Flexible learner	Correlation coefficient	0.576**	0.337	0.413	0.352	0.563**	0.551**
	Sig. (2-tailed)	0.008	0.146	0.071	0.128	0.010	0.012
Confident	Correlation coefficient	0.450*	-0.033	0.293	0.320	0.159	0.360
	Sig. (2-tailed)	0.046	0.891	0.210	0.169	0.503	0.119
Makes connections	Correlation coefficient	0.477*	0.214	0.415	0.486*	0.320	0.414
	Sig. (2-tailed)	0.033	0.364	0.069	0.030	0.169	0.069
Learns independently	Correlation coefficient	0.568**	0.301	0.339	0.441	0.305	0.443
	Sig. (2-tailed)	0.009	0.197	0.143	0.052	0.192	0.051

*Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

In this section, quantitative results of MC2 were reported on. No further adjustments to guidelines were proposed after MC2, as the final intervention in this research was reached, and no testing of further adjustments could thus be done.

5.3 CONCLUSION

In this chapter, the qualitative and the quantitative results of this research were reported on. For each meso-cycle, the qualitative results of the interviews after each intervention were reported on first. Reporting was then done on the factors that hindered transfer (research question 4c) and participants' experiences of the implemented guidelines (research question 4a). After each intervention it was indicated how the suggested guidelines were adjusted to be applied in the next intervention.

The quantitative results of the pre-SRSSDL and the post-SRSSDL and the pre-TLO and the post-TLO were reported on after the discussion of the qualitative results of each meso-cycle. These results aimed to address research question 4b and research question 4d. The results of the TLO and the SRSSDL were furthermore combined and were reported on for the moderate and the high SDL groups.

To determine the factors that promoted transfer (research question 4c), the results need to be integrated. A discussion of the factors that promoted transfer will therefore only be done in chapter 6. Thus, in the following chapter, the results reported on in this chapter will be integrated and interpreted, and a conclusion to this research will be given.

CHAPTER 6:

DISCUSSION OF RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

6.1 INTRODUCTION

The main purpose of this study was to determine how DSDL can be developed in a database module in CAT education. In order to achieve this goal, DSDL first had to be defined and a theoretical foundation for DSDL had to be established. A rationale for DL and SDL therefore had to be provided to propose a theory for DSDL.

In chapter 2, a rationale for DL was provided. Competencies required for DL were discussed, followed by a discussion of transfer of learning and transferable competencies as an outcome of DL. Cognitive load theory (CLT) and social constructivist theory (SCT) were identified as suitable theories to provide a foundation for DSDL. Instructional practices to foster and develop DL were then discussed. Thereafter, a discussion of SDL followed in chapter 3. SDL was defined, the role of the educator in developing SDL was discussed, and competencies required for SDL were elaborated on. Next, DL and SDL were compared and integrated, and a rationale for DSDL was provided. Cooperative learning (CL) was then proposed as a teaching-learning strategy to develop DSDL. Finally, a rationale for DSDL and guidelines to develop DSDL, integrating strategies to promote transfer, CL, CLT, and SCT, were given.

In chapter 4, the research design of this study was elaborated on. The research methodology was explained as design research incorporating an embedded combined convergent and explanatory sequential mixed methods research. Thereafter, the interventions applied to develop DSDL were explained, followed by discussions of selection of the population and the sampling procedure. The Transferable Learning Orientations (TLO) tool, transfer tests, and the Self-Rating Scale of Self-Directed Learning (SRSSDL) were motivated as quantitative data collection instruments. One-on-one and focus group interviews were motivated as qualitative data collection instruments. It was also indicated how data would be analysed and how reliability, validity and ethical issues would be addressed.

In chapter 5, the empirical results of this research were reported on. The sequence of reporting was aligned with the sequence of the research design (see Figure 4.5). For each meso-cycle, the qualitative results of each intervention were reported on first, followed by reporting of the quantitative results. After reporting on the results of each intervention, it was indicated how the proposed guidelines to develop DSDL were adjusted.

In this chapter, the results will be integrated, discussed and concluded on, and recommendations will be made for developing DSDL in a database module in CAT education. The order of the discussion in this chapter will be to provide conclusions with regard to each research question. Conclusions in proposing a theoretical framework and guidelines for DSDL will be discussed first, followed by the conclusions of the empirical investigation. Lastly, the final conclusions of the study and proposed guidelines for DSDL will be presented, the limitations of the study will be indicated, and recommendations for further research will be made.

6.2 CONCLUSIONS IN PROPOSING A THEORETICAL FRAMEWORK, AND GUIDELINES FOR DSDL

In this section, conclusions with regard to the first three research questions of this study will be discussed. A theoretical definition for DSDL will be provided (research question 1), followed by guidelines for instructional practices to develop DSDL (research questions 2 and 3).

6.2.1 Conclusions with regard to research question 1, “How can DSDL be defined theoretically?”

To define DSDL, the processes of DL and SDL first had to be defined, and the relationship between the two processes of DL and SDL had to be established.

SDL was defined as a process in which individuals take responsibility for their own learning. Self-directed learners are required to diagnose their learning needs, formulate their learning goals, identify human and material sources for learning, choose and implement appropriate learning strategies, and evaluate their learning (Knowles, 1975:18). It was further determined that SDL can be defined in view of learner characteristics or attributes, or in view of the outcomes of being a self-directed learner. Various competencies in the cognitive, intrapersonal and interpersonal domains that can be attributed to self-directed learners were accordingly identified (see Table 3.1).

DL was defined as a process that focuses on transfer of knowledge and 21st-century competencies in all three of the cognitive, intrapersonal and interpersonal domains (NRC, 2012:5). In chapter 3, it was concluded that DL and SDL require overlapping competencies in all three domains. Thus, competencies required for DSDL were suggested (see section 3.6), as indicated in Figure 6.1.

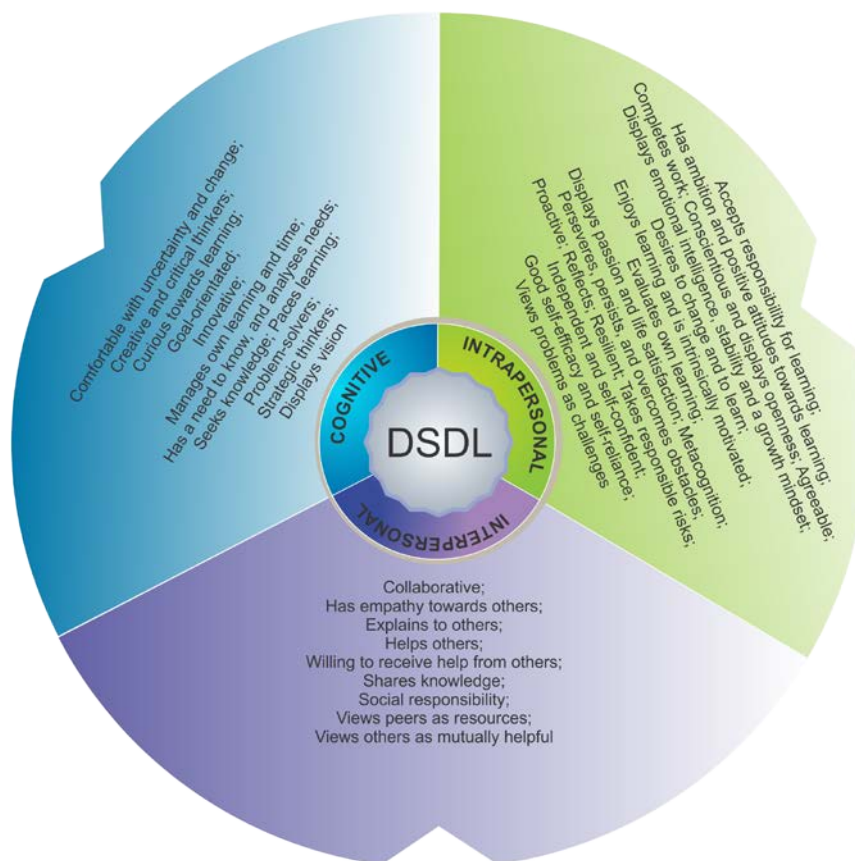


Figure 6.1: Twenty-first-century competencies required for DSDL
(Source: own contribution)

As depicted in Figure 6.2, DSDL is furthermore defined as a process occurring within learners' minds and within social interactions with peers, resulting in transferable 21st-century competencies in the cognitive, intrapersonal and interpersonal domains. These transferable competencies further consist of specific content knowledge, as well as the procedural knowledge of how, why and when to apply knowledge in new and unknown situations. Integrated with and embedded within these competencies is the ability to apply strategies to develop and grow as self-directed learners.

The process of DSDL is further described as a recursive process – while developing competencies required for DSDL, the process of DSDL is continuously being supported (see Figure 6.2). Within DSDL, the processes of SDL and DL thus become recursively intertwined, where the processes mutually drive each other. It was concluded that DSDL can meet the requirements of 21st-century learning. DSDL is thus finally defined as an infinite process that fosters lifelong learning and promotes transfer of knowledge, with the outcomes of taking responsibility for own learning, to obtain transferable competencies.

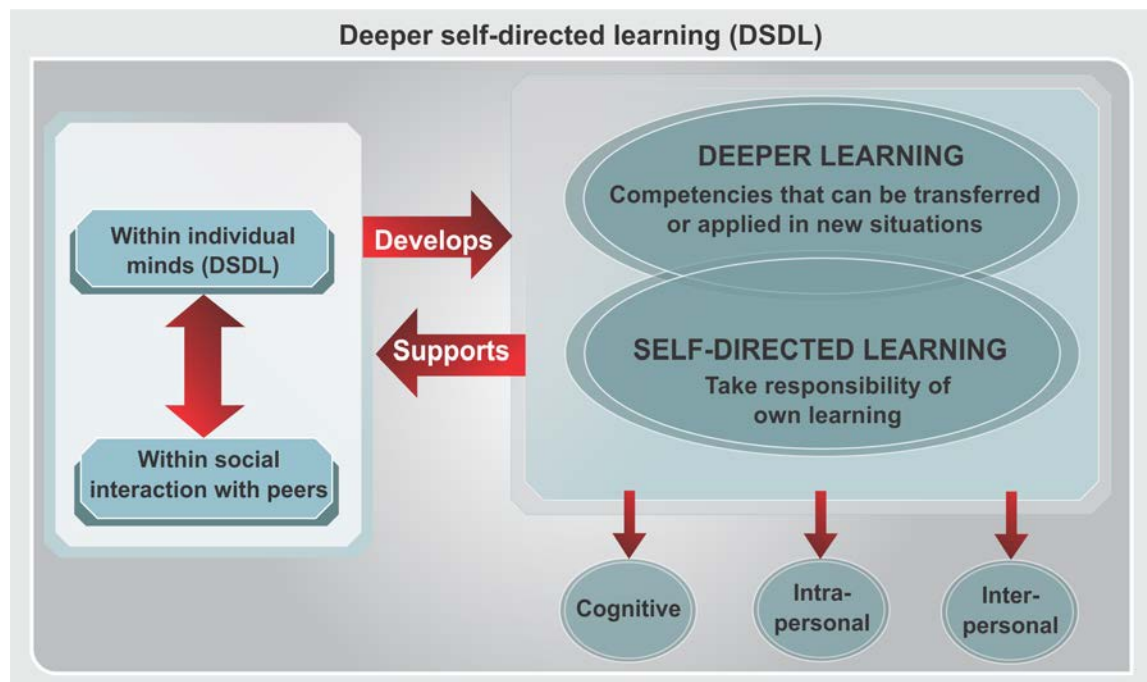


Figure 6.2: The DSDL process to develop and transfer 21st-century competencies
(Source: own contribution)

Cognitive load theory (CLT) (see section 2.3.1) and social constructivist theory (SCT) (see section 2.3.2) were identified as suitable learning theories to serve as the theoretical foundation for DSDL. According to CLT (Sweller, 1988), cognitive loads in the working memory and the long-term memory of students have to be balanced to ensure optimal learning and to thus promote transfer (Paas & Van Gog, 2006; Van Merriënboer *et al.*, 2006; Waris *et al.*, 2015). Especially when engaging in complex tasks (see section 2.3.1) care should be taken to balance the cognitive loads, to improve learning and transfer of learning.

According to SCT (Vygotsky, 1978), learning occurs through social interaction. Knowledge construction takes place by applying reflective thinking and by interacting with and collaborating with peers. Vygotsky (1978:78) stated that all persons have a zone of proximal development, defined as “the distance between the actual development level [that which a person can do or know at that stage] and the level of potential development”, which can be obtained in collaboration with more capable peers. It can thus be said that students are always maturing, and that they have more potential capabilities. What they would probably be able to do at a later stage on their own account can be mastered earlier by collaborating with peers. Thus, to develop DSDL, strategies to balance cognitive loads should be included, and learning should take place while reflecting and collaborating with peers.

Figure 6.3 provides another perspective regarding DSDL. The DSDL process is initiated by a learning need to transfer knowledge and to acquire 21st-century competencies. Without this

learning need, there would be no argument for DSDL. On the boundary of the image lie the cognitive, intrapersonal and interpersonal domains. From each domain, related competencies (see Figure 6.3) branch out. Branching out of the cognitive domain, for example, are the competencies of critical thinking, problem-solving, and creativity. From the intrapersonal domain, the competencies of self-regulation, metacognition, and motivation branch out. The competencies of collaboration, communication, and teamwork branch out of the interpersonal domain. To ensure an uncluttered diagram, only some competencies in each domain have been indicated in Figure 6.3, but all competencies in each specific domain as indicated in Figure 6.1 apply. The DSDL process revolves around these cognitive, intrapersonal and interpersonal competencies, spiralling inwards towards optimal DSDL, without reaching a saturation point on DSDL.

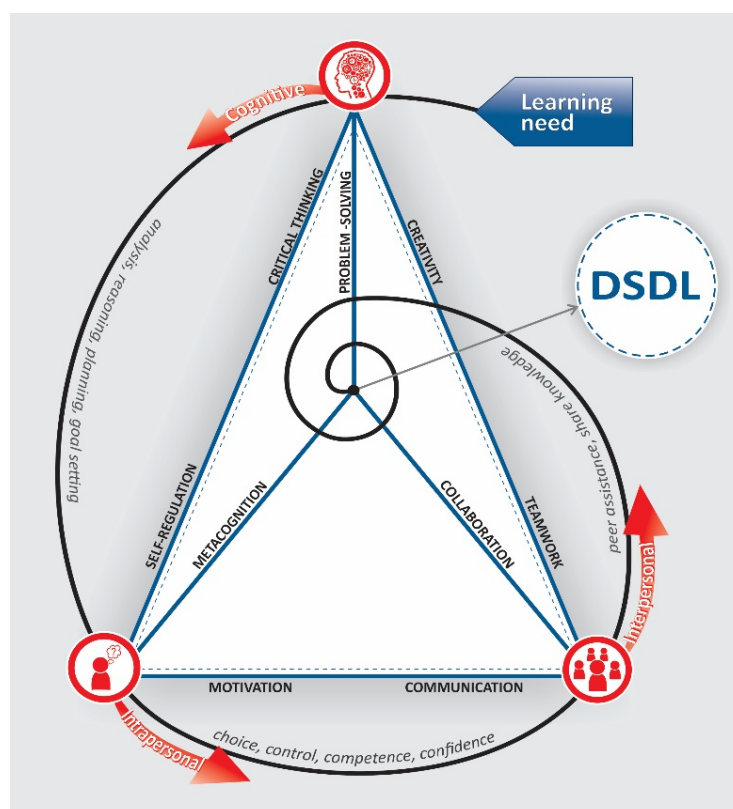


Figure 6.3: Explaining the DSDL process
(Source: own contribution)

As the DSDL process develops and spirals inwards, competencies become more and more intertwined. The process is driven by intrapersonal processes that initiate learning needs and regulate internal processes (intrapersonal competencies), to obtain transferable learning goals (cognitive competencies) and to develop DSDL, while collaborating with peers (interpersonal competencies). Within the intrapersonal competencies that drive the DSDL process are the primary processes of self-regulation, metacognition, and motivation and the secondary

processes of choice, control, competence, and confidence. When analysing, reasoning, planning, and determining goals, cognitive competencies such as problem-solving, critical thinking, and creativity are developed. The development of competencies and the realisation of learning goals occur within social learning environments, with the assistance of peers, who function as a cooperative learning team, who communicate with each other, share knowledge, and build knowledge and skills while assisting each other.

Although it may seem that the inward spiral is collecting competencies linearly, as depicted in Figure 6.3, starting with cognitive competencies, learning is not viewed as a linear process. Application of competencies can occur concurrently and in any order as required by the learning need. The DSDL spiral can thus follow many paths. Further learning needs may be identified when evaluating learning outcomes, thus requiring another cycle of the DSDL process. Learning needs will be deeper in the DSDL process, including a yearning for more knowledge and deeper understanding. Learning needs should also have a lifelong learning focus – to prepare for success in the 21st century.

The ultimate aim of DSDL, therefore, is for learners to take charge and ownership of their learning, to achieve far transfer – the transfer of competencies to new contexts. DSDL thus has the aim of instilling lifelong learning mindsets in deeper self-directed learners, who apply appropriate strategies to develop 21st-century competencies, and who continuously transfer competencies to other subject areas and to the world outside the classroom.

6.2.2 Conclusions with regard to research question 2, “What guidelines regarding instructional practices can be suggested to develop DSDL?”

The outcomes of DSDL will not happen by chance, and they need to be deliberately fostered by teaching and learning. Students’ full potential as self-directed learners and deeper learners has to be realised. Students should therefore be guided to determine their learning needs, focusing on transferable knowledge, to formulate their learning goals accordingly, to identify resources and collaborate with others, to apply critical thinking, to solve problems, to evaluate whether appropriate learning goals and transfer of knowledge have been achieved, and to be encouraged to persist in their learning until their goals have been met.

In chapter 3, CL was proposed as a suitable teaching-learning strategy to develop DSDL (see section 3.5). Guidelines to develop DSDL (see section 3.6 and Figure 6.4) have been based on CL and cooperative pair programming as teaching-learning strategies, while incorporating strategies to incorporate CLT and SCT, strategies to promote transfer, strategies to develop competencies in the cognitive, intrapersonal and interpersonal domains, and strategies to develop SDL. The instructional environment proposed to develop DSDL accordingly strives to reduce cognitive loads on the working memory and to encourage connections with knowledge

and schemas in the long-term memory. Learning should occur within social environments, where learners work in supportive groups to construct knowledge, execute complex tasks, think critically, solve problems, debate solutions, and reflect on activities.

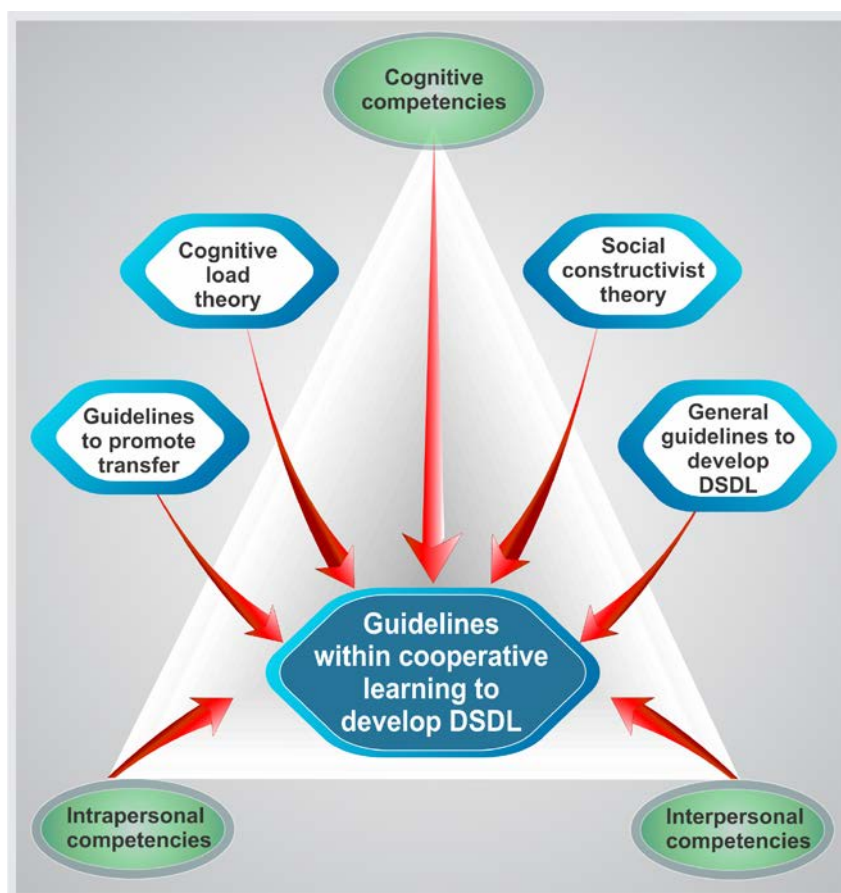


Figure 6.4: Guidelines to develop DSDL
(Source: own contribution)

Specific guidelines to develop DSDL, obtained from the literature, were given in section 3.6. The guidelines were initially divided into seven themes: general guidelines for teaching strategies to develop DSDL (see Table 3.2); guidelines to develop cognitive competencies (see Table 3.3); guidelines to develop intrapersonal competencies (see Table 3.4); guidelines to develop interpersonal competencies (see Table 3.5); guidelines to promote transfer (see Table 3.6); guidelines that support CLT (see Table 3.7); and guidelines that support SCT (see Table 3.8). Specific guidelines for implementing CL and cooperative pair programming as teaching-learning strategies were also provided (see Table 3.9).

According to the theoretical foundation provided for DSDL (see section 3.4.3), the proposed guidelines incorporate the principles on which SCT, CLT, SDL, and DL are based, and are categorised as

1. Guidelines for cooperative learning and cooperative pair programming to develop DSDL,
2. Guidelines to develop cognitive competencies,
3. Guidelines to develop intrapersonal competencies,
4. Guidelines to develop interpersonal competencies,
5. Guidelines to promote transfer, and
6. Guidelines for instructional practices to incorporate CLT and SCT.

In the following section, practical guidelines to develop DSDL in a database module in CAT education, based on the above six categories, will be suggested.

6.2.3 Conclusions with regard to research question 3, “How can the suggested guidelines be implemented in a database module in the Computer Applications Technology education class at university?”

Based on the guidelines for instructional practices to develop DSDL (see tables 3.2 to 3.9), practical guidelines within a CL environment for a database module in the CAT education class at university were proposed (see tables 4.2 and 4.3). The suggested guidelines were implemented, reviewed and refined (see Figure 4.4). Although this module also had a networking component (see section 1.2.6), the guidelines were developed specifically for the database part of the module. The networking part of the module allowed time for analysing data and reviewing the guidelines. In Table 6.1, it is indicated how the guidelines can be implemented in a database module in the CAT education class at university. The suggestions are numbered as 1 to 17, and the numbers of the proposed guidelines, A to AF, as referred to in tables 3.2 to 3.9, are also indicated. In Table 6.1 it is further indicated if a guideline is mainly intended to foster SDL, develop cognitive, intrapersonal or interpersonal competencies, or promote transfer, and whether the guideline is theoretically grounded in CLT or SCT.

Table 6.1: Guidelines to develop DSDL in a database module in CAT education

Guideline no.	Guideline (Table 4.2 and Table 4.3)	Description of guideline	SDL	Cognitive	Intrapersonal	Interpersonal	Transfer	CLT	SCT
1	O, X, Y	Restructure course content for a holistic approach and to revise material. Revisit topics at a deeper level. Provide repeated experience with the same information but in different contexts.		✓			✓	✓	
2	B	Match the level of SDL required to students' level of readiness, and make progression towards student-directed learning over a period of time.	✓	✓	✓	✓			
3	A, D, E, J, K, M	Apply CL or cooperative pair programming as teaching-learning strategies, and include the five essential elements of CL. The roles of navigator and driver are swapped at specific time intervals indicated by the facilitator.	✓	✓	✓	✓	✓	✓	✓
4	AE	Students are assigned randomly to groups by the facilitator to form heterogeneous formal or informal groups. Groups should be limited to four members.	✓	✓	✓	✓		✓	✓
5	W, D	Aim for mastery-approach goals, such as focusing on developing competence and attaining skills, rather than performance goals, by fostering positive interdependence within the groups.	✓	✓	✓	✓	✓		✓
6	AD	Focus on guiding students through inquiry activities first and do some problem-solving, instead of following a tell-first approach.	✓	✓	✓	✓	✓	✓	✓
7	AF	Introduce collaboration scripts to inexperienced groups initially. Care should be taken not to allow collaboration scripts to distract learners' attention and thus limit deep processing of content. In collaboration scripts, indicate when to swap roles. The driver operates the computer, and the navigator brainstorms with the driver to obtain solutions and writes answers on collaboration scripts.	✓	✓	✓	✓	✓	✓	✓
8	F, G	Encourage students to ask essential questions, and cultivate the habit of asking good questions.	✓	✓	✓	✓	✓		

Table 6.1: Guidelines to develop DSDL in a database module in CAT education (cont.)

Guideline no.	Guideline (Table 4.2 and Table 4.3)	Description of guideline	SDL	Cognitive	Intrapersonal	Interpersonal	Transfer	CLT	SCT
9	C	Incorporate complex tasks.		✓	✓	✓	✓	✓	
10	H, P, Q, R, AA, AB, AC	Provide students with worked-out examples, progressing in complexity. Examples must focus on real-life scenarios. Include unsolved problems and incorrect solutions to problems, to be discussed critically and debated in groups to incorporate constructive controversy.	✓	✓	✓	✓	✓	✓	✓
11	Z	Follow a whole-part approach for learning tasks, and order learning tasks in task classes.		✓			✓	✓	
12	L	Include metacognitive questioning.	✓	✓	✓		✓		
13	I	Administer knowledge surveys to students.	✓	✓	✓			✓	
14	S	Provide limited feedback and guidance to learning tasks by the facilitator. Structure learning tasks in task classes.	✓	✓			✓	✓	
15	T	During the group discussion, provide feedback on overzealous transfer.		✓	✓	✓	✓	✓	✓
16	C, N, AA	Give a variety of real-life, complex problems on various scenarios, to assist learners in recognising deep-structure similarities in problem scenarios, to develop far transfer. Focus on comparing and contrasting examples, to identify deep-structure similarities.	✓	✓	✓		✓	✓	
17	U, V	Design and do an authentic task as a database project.	✓	✓	✓	✓	✓	✓	

In this section, it was indicated how guidelines to develop DSDL can be implemented in a database module in CAT education. The guidelines were based on the theoretical foundation provided for DSDL and on the results of data collected during interventions where the proposed guidelines were implemented. In the following section, the conclusions of the empirical testing will be discussed.

6.3 CONCLUSIONS OF THE EMPIRICAL INVESTIGATION

To determine the implications of implementing the suggested guidelines, results of the qualitative data collection and the quantitative data collection will be integrated and discussed. In this section, conclusions with regard to research question 4, “What were the implications of implementing the suggested guidelines in the Cat Education Class at university?” will be discussed. Research question 4 was divided into four research sub-questions, 4a to 4d, and conclusions of each research sub-question will be discussed separately in sections 6.3.1, 6.3.2, 6.3.4 and 6.3.5.

To depict the implications of implementing the guidelines, the qualitative results of the two intervention cycles of each meso-cycle (see Figure 4.5) are summarised in figures 6.5 to 6.8. These figures were drawn by using the ATLAS.ti qualitative data analysis software (see section 4.4.2.2). Each figure depicts the themes that emerged from the data in the categories of the TLO and the SRSSDL questionnaires (see section 4.4.1.2), other SDL attributes, the themes that emerged regarding CL, and participants’ experiences of the implemented guidelines.

The qualitative results presented in figures 6.5 to 6.8 were determined by interviews (see section 4.4.2.1). The number of participants that accepted invitations for interviews differed for each intervention, and therefore the number of participants is also indicated in the caption of each figure. Abbreviations will be used in the discussion to refer to each intervention. The abbreviations “MC1” and “MC2” refer to the first and the second meso-cycles, respectively. Similarly, “INT1” and “INT2” refer to the first and the second intervention cycles, respectively, in each meso-cycle. The notation “MC2 INT1” thus refers to the first intervention cycle of the second meso-cycle.

After giving a brief overview of figures 6.5 to 6.8, the conclusions of each research aim will be discussed and the figures will be interpreted in more detail.

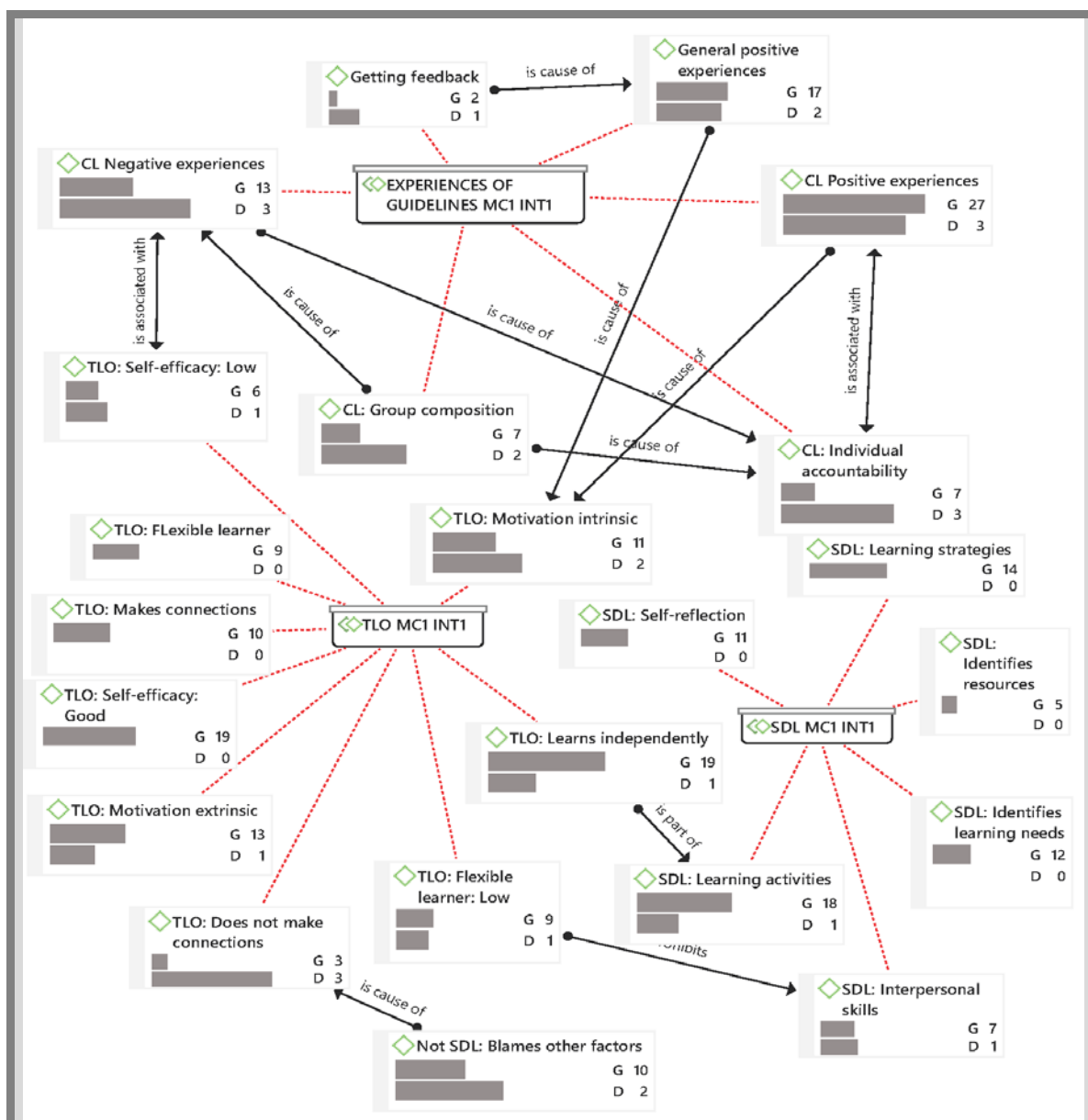


Figure 6.5: Summary of qualitative results after the first intervention of the first meso-cycle (N = 14)

Figure 6.5 depicts the qualitative results of the first intervention of the first meso-cycle (MC1 INT1). Fourteen willing participants participated in individual or focus group interviews (see section 5.1.1.1). Although participants had some negative experiences of CL, the number of positive experiences exceeded the number of negative experiences. Group composition was identified as a theme that contributed to negative experiences. However, from the data it emerged that negative experiences of CL promoted individual accountability. Results further showed positive aspects regarding themes related to the categories of the TLO and the SRSSDL (see section 4.4.1.2), for example good self-efficacy and taking part in SDL activities. Participants were, however, more extrinsically motivated, and they blamed other factors, such as sport commitments and personal issues, for poor performance.

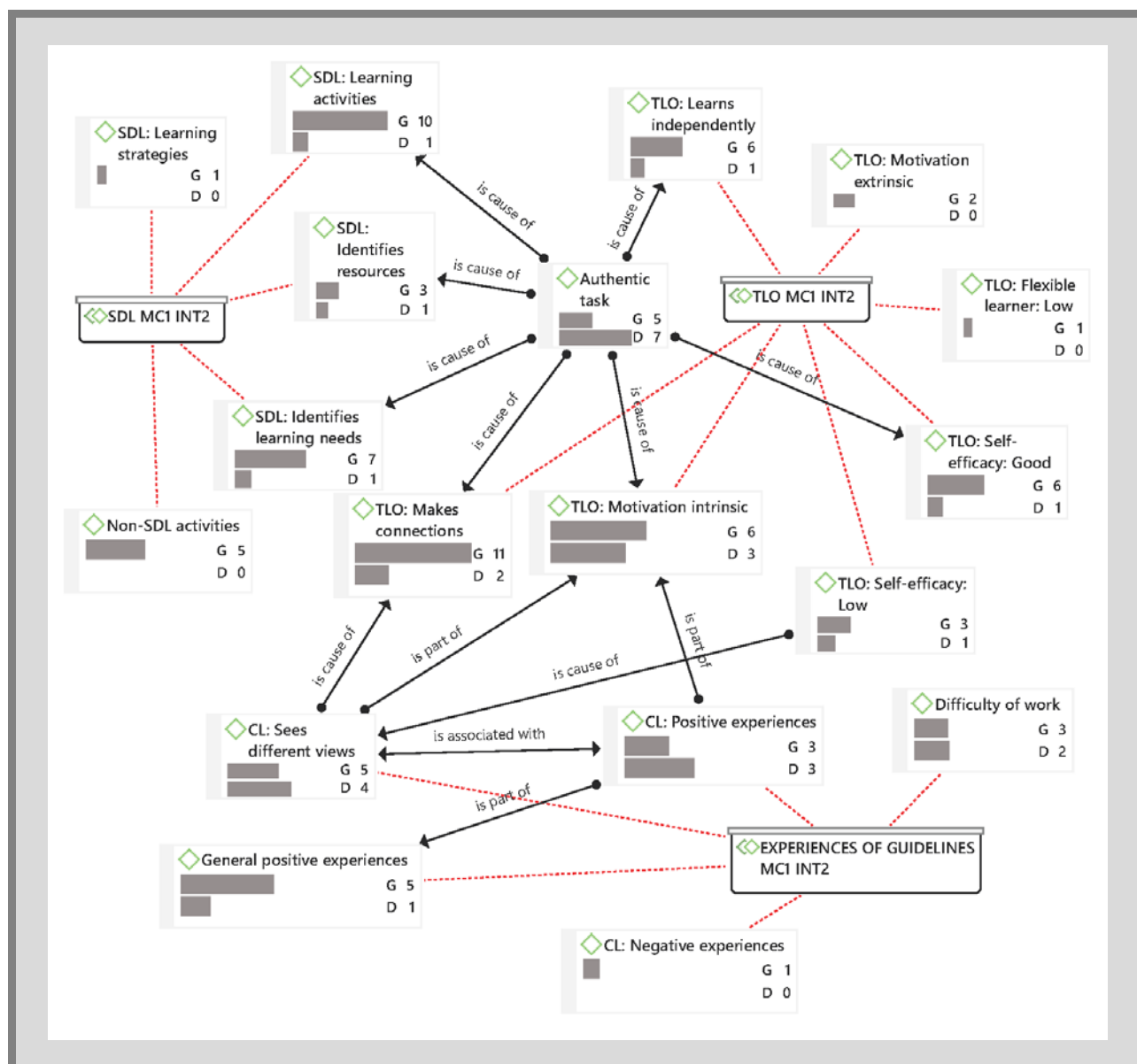


Figure 6.6: Summary of qualitative results after the second intervention of the first meso-cycle (N = 5)

After the second intervention of the first meso-cycle (MC1 INT2), only individual interviews and no focus group interviews were held, as explained in section 5.1.2.1. When viewing the results depicted in Figure 6.6, it should be taken into account that only five participants were willing to be interviewed. Therefore, although the number of positive experiences seems to be few and the impact of the intervention on SDL activities seems to be low, this should be viewed against the number of interviewees. The population consisted of the same group of participants as in MC1 INT1 (see Figure 6.5).

The impact of the authentic task on themes related to categories of the TLO and the SRSSDL was significant. It was also noted that participants were more intrinsically motivated and that they reported fewer negative experiences of CL. A strong theme that emerged was that

participants were inclined to make connections, or to attempt transfer. New themes that emerged were the difficulty of the work and seeing the views of others.

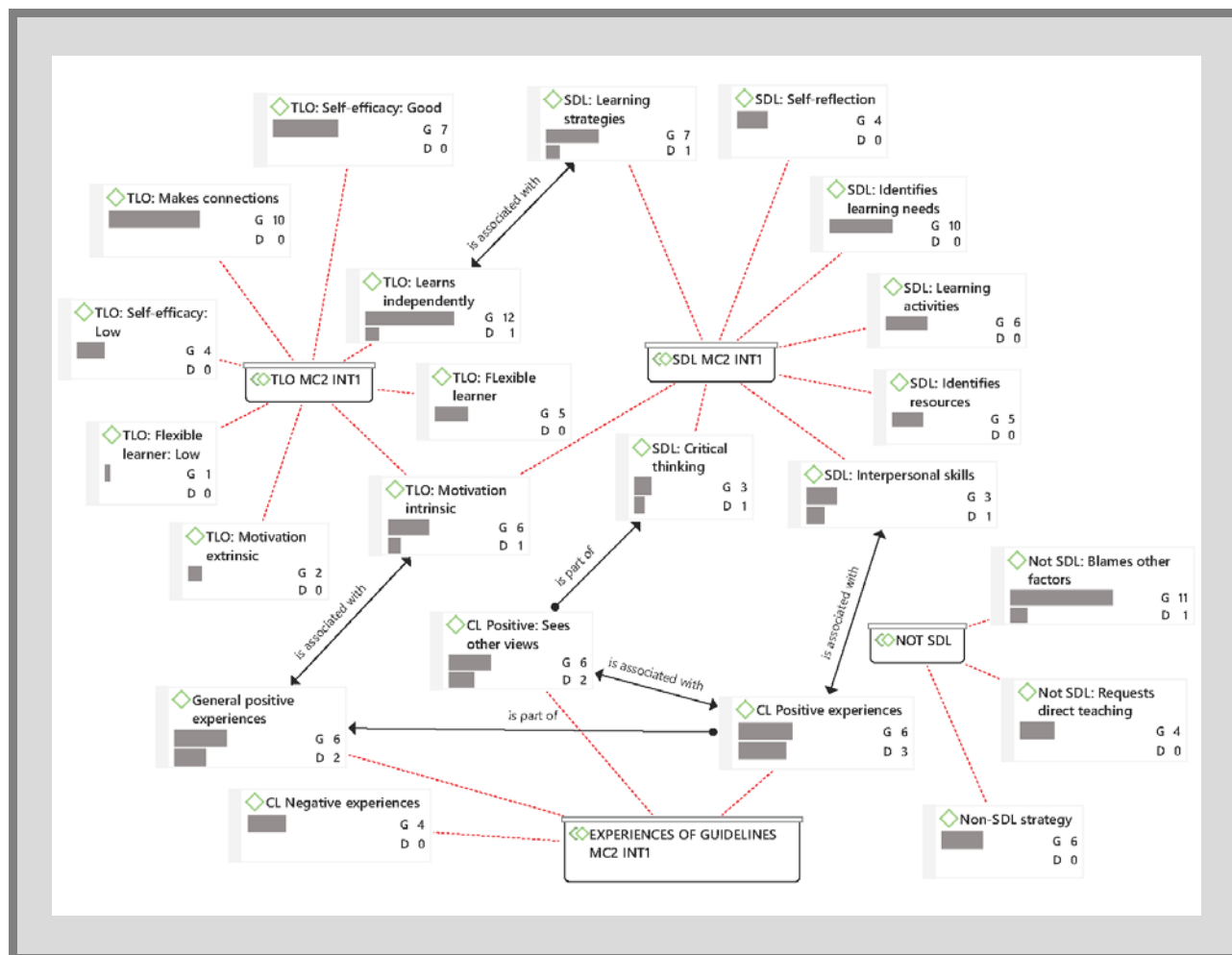


Figure 6.7: Summary of qualitative results after the first intervention of the second meso-cycle (N = 13)

The results as depicted in Figure 6.7 were obtained from individual and focus group interviews after the first intervention cycle of the second meso-cycle (MC2 INT1). In the third year of the research (see Figure 1.1), the intervention cycles were repeated to refine the guidelines, and a new group of participants took part in MC2. Thirteen participants were willing to take part in individual or focus group interviews (see section 5.2.1.1).

Fewer negative experiences were noted in MC2 INT1 than in MC1 INT1 (see Figure 6.5). No themes on issues with the composition of groups, as in MC1 INT1, emerged. The themes of critical thinking and seeing other views emerged in MC2 INT1 (see Figure 6.7), which were not noticed in MC1 INT1. Themes on non-SDL practices, for example blaming other factors for poor performance and requesting direct teaching, were again noted.

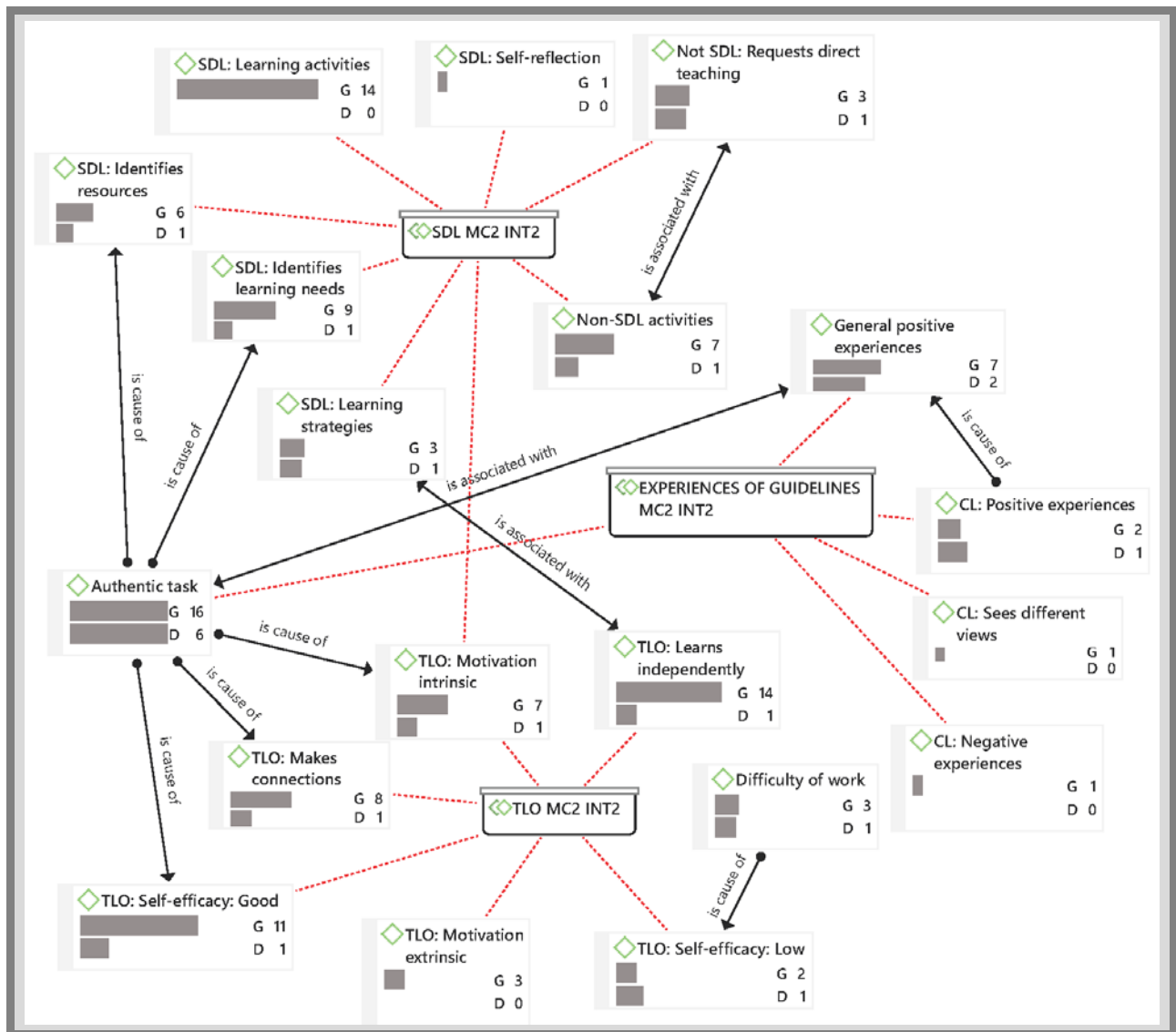


Figure 6.8: Summary of qualitative results after the second intervention of the second meso-cycle (N = 6)

The significance of the authentic task and its impact on other themes was again noticed in the results of MC2 INT2 (see Figure 6.8). Taking into account that only six willing participants participated in individual interviews in MC2 INT2 (see section 5.2.2.1), strong themes emerged on SDL activities, learning independently, and good self-efficacy. As with MC2 INT1, the number of comments linked to intrinsic motivation exceeded the number of comments linked to extrinsic motivation. It thus seems that participants were more intrinsically motivated and that their SDL had improved.

In the following sections, conclusions of each research sub-question (4a, 4b, 4c, and 4d) will be discussed.

6.3.1 Conclusions with regard to research question 4a, “What were students’ experiences of implementation of the guidelines?”

The experiences of the implemented guidelines were determined by the results of the individual and the focus group interviews (see section 4.4.2.1) and by the results of the open-ended questions of the TLO (see section 4.4.1.2.2). Detailed reporting of participants’ experiences of the guidelines was done in sections 5.1.1.3, 5.1.2.3, 5.2.1.3 and 5.2.2.3.

A factor that could have influenced participants’ experiences in the first intervention cycle of each meso-cycle was the different levels of prior knowledge of database design that participants had. Some participants had taken CAT as a school subject, and thus already had knowledge of some database concepts in the first intervention cycles. For other participants, this was their first experience with database design. The database module also historically had the reputation of being difficult, and participants initially had preconceived ideas about the difficulty of the content.

Evidence was obtained that participants found the way in which the course content was structured (see guideline 1 of Table 6.1) to be beneficial. Participants reported that they had ample opportunities to revise and practise difficult concepts. Positive feedback in all intervention cycles was also obtained from the variety of real-life scenarios that were included in problem-solving activities (see guideline 16 of Table 6.1).

Although participants experienced the project (the authentic task) (see guideline 17 of Table 6.1) as challenging, participants reported widely on the learning benefits and other benefits that they experienced from doing the project (see figures 6.6 and 6.8). In both MC1 and MC2, participants’ confidence in their database design abilities improved from the first to the second intervention cycle. The qualitative results indicated that participants’ self-efficacy improved, because they managed to design a database for a real-life scenario and to do a project of such a large scale. Participants further enjoyed working on a project that they had a personal interest in, which motivated them intrinsically. SDL was also developed, as participants had to identify their learning needs and find resources to address their learning needs in order to successfully complete the project. The quantitative results (see Table 5.27) also indicated a possible improvement in self-efficacy and intrinsic motivation, as substantiated by the qualitative results.

Table 6.2 indicates the counts of themes related to participants’ experiences of the implementation of the guidelines, as obtained from figures 6.5 to 6.8. As indicated by Bazeley (2010:443), counts of themes can indicate the importance of themes that emerged from the data. Because a different number of participants took part in interviews after each intervention, the counts were converted to percentages (the number of counts was divided by the number of participants, and the quotient was multiplied by 100). The percentages thus provide a

standardised comparison of the counts of themes. It should further be noted that the frequencies indicated in Table 6.2 and in figures 6.5 to 6.8 refer to the number of quotes connected to a specific theme, and not to the number of participants that reported on a specific theme, hence some of the percentages in Table 6.2 are greater than 100%.

Table 6.2: Frequencies of participants' experiences in all the interventions

Intervention	Source	N	General positive experience	Positive experiences of CL	Negative experiences of CL	Issues with group composition	Sees other views	Difficulty of the content
MC1 INT1	Fig. 6.5	14	17 (121%)	27 (193%)	13 (93%)	7 (50%)	–	–
MC1 INT2	Fig. 6.6	5	5 (100%)	3 (50%)	1 (20%)	–	5 (100%)	3 (60%)
MC2 INT1	Fig. 6.7	13	6 (46%)	6 (46%)	4 (31%)	–	6 (46%)	–
MC2 INT2	Fig. 6.8	6	7 (117%)	2 (33%)	1 (17%)	–	1 (17%)	3 (50%)

As indicated in Table 6.2, participants experienced the implementation of guidelines, which included CL (see guideline 3 of Table 6.1), positively. Although negative experiences from CL also emerged, the number of positive experiences of CL exceeded the number of negative experiences. A significant increase in the number of positive experiences was noted from MC2 INT1 (46%) to MC2 INT2 (117%). Participants reported that they enjoyed databases, that they understood the purpose of databases, and that their views and attitudes regarding databases had changed positively. It was further observed that after each second intervention, fewer participants specifically referred to CL or group work when discussing their experiences of the implemented guidelines (see Table 6.2). A possible explanation could be that because working in CL groups was initially new to most participants, they often mentioned aspects of group work during the first intervention cycles. As indicated by literature, resistance from students can be expected at first when implementing CL (Buchs & Butera, 2015:211; Felder & Brent, 2007:44). In the second intervention cycles of both meso-cycles, participants seemed to have adapted to CL and to have accepted working in CL groups as the norm.

Although it emerged that groups lacked positive interdependence in MC1 INT1, based on the high number of negative group experiences that participants reported (see Figure 6.5), no specific adjustments were made to the guidelines to improve positive interdependence. However, in the second intervention cycles the difficulty of the content (see Table 6.2) and the complexity of the tasks (see guideline 9 of Table 6.1) increased. Furthermore, the differences

between participants' levels of prior knowledge diminished. In the first intervention cycle, large differences between students' levels of prior knowledge existed, as already explained in this section. In the second intervention, students' levels of prior knowledge were more similar. New topics, such as modelling database design with ER diagrams and database normalisation, were introduced, which were new and difficult concepts for most participants. The lack of positive interdependence that was observed in the first intervention cycles was thus not noticed as a prominent theme in the second intervention cycles. This observation can most likely be attributed to the high intrinsic cognitive load that all group members experienced when solving complex problems. These observations agree with the suggestion of Janssen *et al.* (2010:145) and Kirschner *et al.* (2018:218) that group tasks that are viewed as complex tasks by all group members will necessitate working together. Participants were thus more positively interdependent (guideline 5, Table 6.1) as the complexity of tasks increased. As stated in the literature, the functioning of groups improves when they have to work on complex tasks (Johnson & Johnson, 2017:287; Kirschner *et al.*, 2011:622; Slavin, 2013:190).

One aspect of group work that participants found especially beneficial was to see other views (see guidelines 10 and 16 of Table 6.1) on the problems that had to be solved (see Table 6.2). This was first noticed in MC1 INT2, but it was also noticed in MC2 INT1 and MC2 INT2. To see multiple views and perspectives is indicated by Stearns (2017:72) as an important aspect of social constructivist learning, which can develop transfer of knowledge and learning (see section 2.3.2). Experiences where participants could share their views and debate possible solutions to problems (see guideline 10 of Table 6.1) developed their critical thinking and improved their understanding of concepts. As already explained above, complex tasks in the second intervention cycles could have assisted in promoting positive interdependence, which paved the way for group members to be open to each other's views.

It can be speculated why the theme of multiple views did not emerge in MC1 INT1. In MC1 INT1, some participants reported negative experiences of CL (see Table 6.2), because of how participants were assigned to groups (see guideline 4 of Table 6.1) (issues with group composition were not noticed in the other intervention cycles). Although participants were already in their third year of study, the results indicated that they lacked group skills. Participants reported that they preferred working with peers who were in their circle of friends, or with peers who understood the work and were helpful. Negative experiences thus mainly resulted from working with unfamiliar peers who were unsure of the work, were not prepared for class, and/or were not helpful towards their group. It is thus speculated that these issues prevented participants from being open to the views of peers. Negative experiences, however, also had positive outcomes. When participants did not know who they would be working with in

the next class it motivated them to prepare for class, and it thus fostered their individual accountability. Negative group experiences were mostly limited to MC1 INT1 (see Table 6.2).

To address participants' negative experiences with group composition, collaboration scripts (Fischer *et al.*, 2013:64) (see guideline 7 of Table 6.1) were introduced in MC2 INT1 to guide inexperienced pair programming groups. The aim was thus to reduce the extraneous cognitive load imposed by transactive group activities on novice pair programming groups (see section 2.3.1.3). No negative experiences regarding group composition were reported after that. This zero count can possibly be attributed to the introduction of the collaboration scripts in MC2 INT1. It can thus be speculated that less extraneous cognitive load was imposed by transactive group activities (see section 2.3.1.3). Because group members received guidance on their roles in the cooperative pair programming groups, they could focus on the group tasks and the problems that had to be solved. As a result, it seemed that the dynamics between group members improved, and that participants were more open to the views of their peers and realised the benefit of seeing other views.

Participants from the successful transfer group also reported negative experiences in both meso-cycles, mostly during the first intervention cycles (see figures 6.5 and 6.7). They felt that they were the ones who were prepared, who understood the work, and who had to do all the explaining in their groups, and that the members of their group did not contribute towards the task at hand and to their learning. A lack of positive interdependence was thus especially noticed in these groups in MC1 INT1 and MC2 INT1 (see sections 5.1.1.3 and 5.2.1.3). It should further be noted that all participants from the successful transfer group had taken CAT as a school subject, and that they thus had prior knowledge of databases. In the second interventions, negative experiences were fewer. Overall, the frequency of reporting on negative experiences after the second interventions of each meso-cycle decreased significantly compared to the frequency of negative experiences after the first interventions of each meso-cycle. In MC1, the percentage of negative experiences dropped from 93% to 20%, and in MC2, the percentage dropped from 31% to 17% (see Table 6.2).

Possible reasons for the drop in percentages can be that the differences in participants' prior knowledge levelled out. As indicated by Yang *et al.* (2018:37), levels of prior knowledge can affect students' approach to learning and motivation. As already explained above, the complexity of tasks and the difficulty of the content could also have contributed to improved positive interdependence between group members. Furthermore, with the ongoing participation in CL groups, participants' interpersonal skills should have developed, they should have gained more experience at working in CL groups, and they should have realised the benefits of CL.

Working in CL groups gave participants opportunities to succeed in complex tasks, which boosted their confidence (see guideline 5 of Table 6.1). In their groups, participants succeeded, for example, in creating relationships between database tables, and they could develop solutions to complex ER diagrams, despite their fears of those complex tasks.

In conclusion, regarding participants' experiences of the implemented guidelines, it can be stated that improvements in participants' competencies in the cognitive, intrapersonal and interpersonal domains were noticed from the first to the second interventions. Although some negative experiences were initially reported, literature indicates that resistance from students can be expected at first when implementing CL (Buchs & Butera, 2015:211; Felder & Brent, 2007:44). Improvements in group skills, in individual accountability, and in positive interdependence, and a growing acceptance and appreciation of the implemented guidelines were noticed despite the initial negative experiences. Positive interdependence between group members improved as the complexity of tasks increased. Working in groups gave students the opportunity to be successful when solving complex tasks, which consequently improved their confidence in the subject. Participants appreciated the input and the views of other students, their critical thinking skills improved, and they were less intimidated by group debates. The authentic task further contributed to improving participants' understanding of database concepts, it boosted their confidence, it fostered their intrinsic motivation, and it developed their SDL. Participants thus changed their negative mindsets regarding databases, and they responded positively to implementation of the guidelines.

6.3.2 Conclusions with regard to research question 4b, "What was the effect of deliberate implementation of the suggested guidelines on transfer of competencies?"

To determine the effect of deliberate implementation of the suggested guidelines on transfer of competencies, the results of quantitative and qualitative data collection instruments were used (see Table 4.4). Therefore, to answer research question 4b, the following results were focused on: the results of the TLO for the category "makes connections" (see sections 5.1.4.2 and 5.2.4.2), the results of the transfer tests (see sections 5.1.1.1, 5.1.2.1, 5.2.1.1 and 5.2.2.1), the open-ended questions of the TLO, and the results of the interviews (see sections 5.1.1.3.2, 5.1.2.3.3, 5.2.1.3.2 and 5.2.2.3.2).

Transfer tests (see section 4.4.1.1) were written after each intervention, to quantitatively determine to what extent transfer had occurred. Results of the transfer tests after the first and the second interventions were not compared with each other, as the tests were based on different content. Some concepts were, however, assessed in both transfer tests. Participants were expected to have improved transfer of such concepts, because they had obtained more

experience and skills in these concepts. Topics such as ER diagrams and normalisation, which were introduced in the second intervention, and were thus assessed in the second transfer test, were, however, not only new concepts, but were also more demanding than topics assessed in the first transfer test. Participants therefore experienced the second transfer test of each meso-cycle as more difficult than the first transfer test.

The quantitative results of the TLO (see tables 5.9 and 5.27) indicated improvements in the means of the “makes connections” category, with a small effect, in both meso-cycles for all participants. The means of the “makes connections” category of both the moderate SDL ($d = 0.40$) and the high SDL ($d = 0.45$) groups improved with a medium effect (see Table 5.30). The results of the quantitative data thus showed that participants’ inclination to transfer competencies might have improved, which is promising. However, because of the small sample sizes, explanation about the possible improvement had to be obtained from the results of the qualitative data.

The results of the qualitative data indicated that participants transferred their knowledge to new scenarios. As can be seen in figures 6.6 and 6.8, the category “makes connections” emerged as a strong theme after the second intervention cycle of each meso-cycle. In Table 6.3 the counts of quotes that were related to the theme “makes connections” (see figures 6.5 to 6.8) are indicated. To enable standardised comparison between the various interventions, the percentages of quotes in relation to the number of participants were again calculated, as already explained in section 6.3.1. They are presented in Table 6.3.

Table 6.3: Frequencies of quotes related to transfer in the first and the second meso-cycles

Intervention	Figure	N	Makes connections	Does not make connections
MC1 INT1	6.5	14	10 (71%)	3 (21%)
MC1 INT2	6.6	5	11 (220%)	0
MC2 INT1	6.7	13	10 (77%)	0
MC2 INT2	6.8	6	8 (133%)	0

In MC1, the percentage of quotes related to the theme “makes connections” increased from 71% to 220% from the first to the second intervention cycle. In MC2, the percentage increased from 77% to 133%. After MC1 INT1, three quotes were linked to the theme “does not make connections”. No quotes from the other interventions were linked to this theme. The qualitative results of both meso-cycles thus substantiate the quantitative results, and this indicates that implementation of the guidelines improved transfer of competencies. The following are some of the responses to the open-ended questions of the TLO:

I feel that we obtained a lot of additional knowledge and skills, which will be very valuable to apply in other subjects and in a real-life situation.

By solving problems, it taught me a lot in terms of how I can use the knowledge that I have in the world.

From the qualitative data, it further emerged that problem-solving skills, applying knowledge of databases to other scenarios, group work skills, finding ways to deal with challenges, time management, and planning were competencies that participants indicated they would transfer to other situations. It can further be concluded that far transfer of competencies was implicated, as participants mentioned that they would apply their knowledge to new scenarios, to other subject areas, and to the world.

With regard to research question 4b, it is thus concluded that implementation of the suggested guidelines promoted both near and far transfer. In the following section, factors that hindered or promoted transfer will be elaborated on.

6.3.3 Conclusions with regard to research question 4c, “What factors hindered or promoted transfer?”

Although it was concluded in section 6.3.2 that the implemented guidelines promoted transfer, research question 4c aimed to determine the factors that hindered or promoted transfer. To answer research question 4c, the factors that hindered transfer will be discussed first, followed by the factors that promoted transfer.

6.3.3.1 Factors that hindered transfer

Transfer tests were used as anchor documents in the one-on-one interviews (see section 4.4.2.1.2), to assist with identifying the factors that hindered transfer. Factors that hindered transfer were then identified by the themes that emerged from the qualitative data (see Table 6.4).

The specific interventions after which the factors were identified, as well as the numbers of the diagrams that depict the results in chapter 5, are indicated in the first two columns of Table 6.4. Because the number of participants differed in each intervention, the number of quotes related to each theme was again calculated as a percentage of the number of participants, as already explained above.

Table 6.4: Factors that hindered transfer, according to themes from the qualitative data

Intervention	Figures that depict data	Rushing for time	Problem-solving	Read and interpret questions	Verify solution	Data types	Primary key	Formulate conditions	Identify fields to connect	Delete relationship	Abstraction	Syntax of ER diagram	Refine ER diagram	Lack of knowledge	Personal issues
MC1 INT1 (N = 14)	5.1	14	18	31	–	22	4	9	17	8	–	–	–	–	–
	5.2	100%	130%	220%	–	160%	30%	60%	120%	60%	–	–	–	–	–
MC1 INT2 (N = 5)	5.6	3	–	3	–	1	–	–	–	–	8	4	6	–	–
		50%	–	50%	–	20%	–	–	–	–	160%	80%	120%	–	–
MC2 INT1 (N = 13)	5.14	12	15	15	5	7	6	16	10	2	–	–	–	3	–
	5.15														
	5.16	90%	120%	120%	40%	50%	50%	120%	80%	20%	–	–	–	20%	–
MC2 INT2 (N = 6)	5.20	16	2	9	1	3	2	–	3	–	4	–	4	–	6
		270%	30%	150%	20%	50%	30%	–	50%	–	70%	–	70%	–	100%

A strong theme that emerged from the data was that participants were rushed, because they feared they would not complete the transfer test in time. In MC2 INT2, for example, 16 quotes (270%) were linked to this theme. Participants mentioned that they felt they were able to answer questions correctly but that the test environment hindered them from solving problems correctly. Environments where participants feel anxious and rushed for time can be described as “inadequate for transfer” (Herrington *et al.*, 2006a:191). Because the transfer test was part of the module’s assessment plan, participants felt rushed and stressed, which can be viewed as factors that hindered transfer. It should further be kept in mind that this module has historically been viewed as being difficult by students, and this contributed to participants’ stress levels when they wrote the transfer tests.

Participants misread questions, or they did not verify their solutions, because they ran out of time. Other participants were confident that they had solved the problems correctly, and they therefore did not verify their solutions. Reading and interpreting questions correctly and verifying solutions are considered integral to problem-solving. Applying appropriate problem-solving strategies was thus another factor that hindered transfer. Problem-solving issues were, however, more frequent in the first intervention cycles. As indicated in Table 6.4, 18 quotes (130%) were linked to having issues with problem-solving strategies in MC1 INT1, and 15 quotes (120%) were linked to this factor in MC2 INT1. However, in both of the second

intervention cycles (MC1 INT2 and MC2 INT2), issues with problem-solving strategies did not emerge as strong themes (0% and 30%). These observations suggest that as participants were more exposed to the implemented guidelines, their problem-solving skills improved.

Creating relationships and designing queries can both be described as complex tasks (see figures 5.15 and 5.16). As explained by Paas *et al.* (2010:116), a large number of elements need to be processed simultaneously when engaging in complex tasks. Therefore, when uncertainties existed regarding data types, primary keys, or formulating conditions, these were all obstacles to transfer. If participants could not identify which fields to connect, or they incorrectly assigned a primary key, or they could not delete a relationship that they wanted to correct, they were hindered in transferring their knowledge to create correct solutions. These obstacles were, however, not so prominent in the second intervention of each meso-cycle (see Table 6.4). Participants' competencies in handling these obstacles to transfer thus improved with time, as would be expected with increased experience.

Some misconceptions related to concepts were identified, which could have hindered transfer. When assigning primary keys, participants often only focused on the uniqueness aspect of primary keys. They did not take into account that the value of the primary key should stay constant, or that a value is required. Participants, for example, chose the cell phone number as the primary key, reasoning that each person's cell phone number will be unique. They, however, did not take into account that a person's cell phone number can change, or that some people might not have cell phone numbers.

Misconceptions related to data types were also noted. Participants confused the various data types, or they were not careful in assigning the correct data types to fields. When, for example, participants did not assign a numerical data type to a numerical value, transfer was hindered when they attempted to design a query in which conditions had to be formulated or formulas had to be devised using those numerical values.

Participants could explain the relationships between the entities of a scenario, and they could interpret a given ER diagram. However, designing an ER diagram and drawing an abstract representation of a scenario emerged as a factor that hindered transfer (see Table 6.4). Designing ER diagrams was one of the topics introduced in the second intervention of each meso-cycle. Limited time was available for acquiring new knowledge and improving competencies in the second interventions. Leaf (2018:78) suggests that 21 days are required to build one's long-term memory, and that 42 days are required to build thinking habits. The module in which the research was done consisted of two components, namely database design and computer networking. Although 11 weeks were allocated for this module, only six weeks were allocated for the database component. Three weeks were thus allocated for each

intervention (see Figure 4.5). Furthermore, only two class contact sessions were scheduled in a week, with a total contact time of three hours per week. In total, 12 contact sessions, and thus only six contact sessions per intervention, were scheduled for the database part of the module, which did not allow much class time to master complex database concepts.

Another factor that hindered transfer was lack of knowledge due to personal issues that participants experienced. This factor, however, did not emerge as a strong theme, and it is only mentioned for the sake of completeness, as it is an obvious obstacle to transfer. This factor will therefore not be discussed further.

With regard to the first part of research question 4c, it is concluded that the following factors hindered transfer: being rushed for time and writing the transfer test as part of the module's assessment plan; misreading and misinterpreting questions, not verifying solutions, or not applying appropriate problem-solving skills; misconceptions related to primary keys, and not assigning correct data types to fields; and the limited time in which complex tasks had to be mastered in the second interventions.

In the following section, the second part of research question 4c, namely the factors that promoted transfer, will be discussed.

6.3.3.2 Factors that promoted transfer

One main outcome of DSDL is to transfer knowledge. The guidelines for DSDL were therefore formulated specifically to foster transfer. In section 6.3.2 it was concluded that transfer of competencies had occurred after implementing the suggested guidelines. Factors that promoted transfer were identified by analysing themes that emerged from the qualitative data and from guidelines obtained from the literature.

From the qualitative data, three specific factors that promoted transfer emerged: seeing the different views of peers when solving problems in CL groups (see figures 6.6, 6.7 and 6.8), doing an authentic task (see figures 6.6 and 6.8), and repeated application of knowledge. Working in CL groups gave participants confidence to solve problems, and it exposed them to different views. The various problem scenarios that participants were exposed to could also be a factor that promoted transfer.

The authentic task could be another factor that promoted transfer, or the making of connections to other scenarios (see figures 6.6 and 6.8). Participants had the opportunity to choose their own scenarios for designing a database solution, thus applying their knowledge to an authentic scenario. Because of the scale of the authentic task, participants repeatedly had to reinforce their prior knowledge. This, along with the way in which the course content was structured, further helped participants to form schemas and to obtain a deeper understanding of how the

various objects in a database are interrelated. Participants could thus form schemas in their long-term memory and acquire deep content knowledge, which is required for transfer. Participants' improvement in problem-solving skills (see Table 6.4) can also be attributed to the authentic task. The observation that problem-solving skills improved can also indicate that problem-solving competencies were transferred. As participants' problem-solving skills improved, they obtained more confidence in database design and were more intrinsically motivated, and thus transfer was promoted. This is consistent with Blume *et al.* (2010:1096), who identified cognitive ability, self-efficacy, and motivation as having strong relationships with transfer.

Embedded in the factors that promoted transfer, as obtained from the qualitative data, are strategies to promote transfer, as obtained from the literature (see tables 3.2 to 3.9), which were incorporated in the guidelines. As suggested by Blume *et al.* (2010), various strategies to promote transfer were incorporated in the suggested guidelines to develop DSDL. Cooperative pair programming and CL were applied as teaching-learning strategies, discussion opportunities with groups were provided, participants had repeated experience with the same information, strategies were applied to balance cognitive loads, participants had to design their own scenarios in the form of authentic tasks, and participants were encouraged to focus on mastery-approach goals instead of performance goals.

It is thus concluded that factors cannot be singled out as having promoted transfer of competencies, but that the multiple strategies to promote transfer that were incorporated in the guidelines for DSDL promoted transfer.

6.3.4 Conclusions with regard to research question 4d, “What was the effect of deliberate implementation of the suggested guidelines on students' self-directed learning?”

Students were expected to be self-directed learners, who constantly pursued knowledge, who learnt with others, and who learnt independently, to build on their competencies in the cognitive, intrapersonal and interpersonal domains. As indicated above in section 6.3.3.1, limited class time was scheduled for this module, and difficult content had to be mastered in a relatively short period of time. Therefore, students' SDL had to be developed in order for them to identify their learning needs and use appropriate strategies to take control of and be responsible for their own learning.

The quantitative results from the SRSSDL from both meso-cycles (see tables 5.5 and 5.22) show an improvement in the total SDL scores, but with no significant effect size. In MC2, an improvement is noted in the mean scores of the “learning activities”, “evaluation” and

“interpersonal skills” categories of the SRSSDL (see Table 5.22), but with no significant effect sizes.

Although no statistically significant results were obtained, there are some promising results. In each meso-cycle, the number of participants that improved their total SDL score exceeded the number of participants whose total SDL score decreased (see tables 5.7 and 5.24). In the high SDL group of MC2, the mean scores of all categories except the “awareness” category improved (see Table 5.23). The mean scores of the categories “learning activities” ($d = 0.38$) and “evaluation” ($d = 0.39$) both improved with a medium effect size. Not the same improvements were, however, noted in the moderate SDL group (see Table 5.23) in MC2. Although the mean scores of the “interpersonal skills” category of the moderate SDL group improved with a small effect ($d = 0.25$), the mean scores of most other categories, as well as the total SDL score, decreased with a medium to a large effect. A possible reason can be that these participants in the moderate SDL group were not supported enough by the teaching strategy applied during the intervention. As indicated by Grow (1991:125) support should be provided to students that are less self-directed in their learning, to assist them in improving their SDL.

To obtain statistically significant results with small numbers of participants, as in this study, is not always feasible. It can only be speculated why the mean values of the “awareness” category decreased (see Table 5.23). Self-directed learning is a prominent focus of the faculty in which this module resided, and being third-year students, participants might have viewed themselves as having a higher level of SDL. One participant specifically indicated in the open-ended questions of the TLO that they needed to be self-directed. It can, however, be questioned whether this participant understood the meaning of SDL, as she later indicated in the post-TLO that she had realised that she had to apply SDL competencies. With the post-SRSSDL, participants might thus have rated themselves lower, because they became more aware of their lack of SDL characteristics, and because of the demands that the difficult content of the module made.

It can further be speculated why most improvements are noticed in the high SDL group (see Table 5.23). It is possible that the high SDL group had a more realistic assessment of their SDL characteristics. The moderate SDL group, however, might have overrated their SDL characteristics and after the interventions might have realised that their SDL characteristics were lower than they had initially envisaged. In this regard, it has been reported in the literature that participants often initially score themselves as more self-directed (Van der Walt, 2014:7). Another possible reason could be that because of the difficulty of the work, the participants of the moderate SDL group felt incompetent, which affected their opinion of their SDL (Long, 2000:21). The small number of participants in the moderate SDL groups ($N = 8$, MC1; $N = 3$,

MC2) is also a factor that could have prevented statistically significant results. Although some promising results were noted, other results are required to provide more insight into the effect of implementation of the guidelines on participants' SDL.

The results of the TLO can be used to obtain more insight into the effect of the implemented guidelines on participants' SDL. The categories of the TLO correspond to SDL characteristics. According to Long (2000:22), self-directed learners will experience more feelings of competence and confidence. Intrinsic motivation, good self-efficacy, and learning independently have also been indicated as characteristics of self-directed learners (see section 3.2.1).

The quantitative results of the TLO in MC2 (see Table 5.27) indicated that the mean scores of all categories of the TLO improved with small to medium effect sizes. When viewing the results of the TLO according to the moderate SDL and the high SDL groups (see Table 5.30), a different picture is observed with the moderate SDL group than mentioned above with the results of the SRSSDL. In all categories of the TLO, the mean scores of the moderate SDL group improved with a medium to a large effect, except in the extrinsic motivation category. This could confirm the above speculation that the participants of the moderate SDL group initially overrated themselves with the SRSSDL. The improvement in the mean scores in the categories of the TLO may therefore indicate that participants' SDL characteristics improved.

The TLO results of the high SDL group (see Table 5.30) also showed an improvement in all categories, with a small to a medium effect, except in the "confident" category. The decrease in the mean of the "confident" category is, however, not significant, due to the small effect size. However, it could be that participants were initially confident of their database knowledge, but that the increase in the difficulty of the content of the module affected their confidence levels. As indicated by the increase in the means of the "intrinsically self-motivated", "flexible learner" and "learns independently" categories of the TLO, however, the SDL characteristics of the moderate and high SDL groups could have improved.

Correlations between the categories of the TLO and the categories of the SRSSDL were also observed. In MC2, the total SDL scores of the pre-SRSSDL indicated correlations with the categories "self-motivated_int", "flexible learner" and "makes connections" of the pre-TLO (see Table 5.31). Although these correlations can only be speculated on, the qualitative data results indicated that not being a flexible learner prevented development of interpersonal skills (see Figure 6.5). Having good interpersonal skills is a characteristic of SDL, and it was also associated with a positive experience of CL in the qualitative data results (see figures 6.7 and 6.8). A positive experience of CL, in turn, was associated with an overall positive experience of the implemented guidelines (see Figure 6.8), which could have fostered intrinsic motivation.

In MC2, several correlations with the results of the quantitative data were noted between categories of the post-SRSSDL and categories of the post-TLO (see Table 5.32). The “flexible learner” category of the post-TLO correlated with the “awareness” and the “interpersonal skills” categories of the post-SRSSDL, as well as with the total SDL score. The “makes connections” category of the post-TLO correlated with the “awareness” and the “evaluation” categories of the post-SRSSDL. When viewing these correlations from another perspective, the “awareness” category of the post-SRSSDL correlated with the “flexible learner”, the “confident”, the “makes connections” and the “learns independently” categories of the post-TLO. More research is, however, required to interpret these correlations.

To further determine if the implemented guidelines had developed participants’ SDL, the results of the qualitative data will be considered. The qualitative data results revealed that although participants initially displayed SDL characteristics and viewed themselves as being self-directed learners, they initially lacked SDL skills and characteristics in the first intervention cycles (see figures 6.5 and 6.7). They did not always apply SDL learning strategies and activities, and some participants still requested direct teaching. Participants were also initially more extrinsically motivated (see figures 6.5 and 6.7). They preferred handing in all assignments for marks, and they even wanted to get marks for the preparation they had done for class. Participants thus in MC1 INT1 and MC2 INT1 did not always understand the value of doing assignments in order to master skills, and not for performance goals to obtain marks.

The quantitative results of the pre-TLO in MC1 INT1 and MC2 INT1 (see tables 5.9 and 5.26) confirmed that participants were less intrinsically motivated, and were thus instead motivated by extrinsic factors. Participants also scored low on organisation (learning independently), and were therefore generally not independent learners initially. They, however, initially viewed themselves as confident and flexible learners.

The qualitative data analysis for both meso-cycles indicates an improvement in SDL characteristics and skills (see figures 6.5 to 6.8). It seemed that the implemented guidelines encouraged participants to apply more SDL activities and to identify resources to assist them in understanding the content. Participants also became more aware of their learning needs. Participants further indicated that they improved their time management and thus allowed themselves more time to work on tasks. The authentic task should also be mentioned here, as it was identified as a factor that improved participants’ SDL characteristics and activities, as indicated in figures 6.6 and 6.8.

It further emerged from the qualitative data that for both meso-cycles participants were more intrinsically motivated after the second intervention cycles (see figures 6.6 and 6.8). Intrinsic motivation is often associated with curiosity and a desire for challenge (Long, 2000; Ryan &

Deci, 2000a), both of which are characteristics of highly self-directed learners (Edmondson *et al.*, 2012; Guglielmino, 1978). Participants accordingly indicated that they enjoyed the challenges posed to them, and that they were willing to find solutions to problems.

Participants' positive experiences thus boosted their self-efficacy, their confidence, and their belief that they were able to succeed. Self-efficacy is viewed as a key characteristic of self-directed learners (see section 3.4.1.2). As indicated by Long (2000), self-directed learners will experience more feelings of competence and confidence, which should urge them to make more effort, set higher goals and be committed to them (Bandura, 1993:118). It has already been indicated in section 6.3.1 that participants' problem-solving skills improved. According to Long (2000:18), metacognition is displayed by students who engage in problem-solving and evaluate and adapt strategies during problem-solving. Participants who improved their problem-solving strategies thus also might have improved their metacognitive skills, and thus their competencies in the intrapersonal domain.

From the above discussion it can be concluded that the implemented guidelines developed participants' SDL. Although the results of the SRSSDL are inconclusive regarding the effect of the implemented guidelines on participants' SDL, the results of the TLO and the qualitative data support the possibility that participants' SDL characteristics, SDL learning strategies and SDL activities improved.

After discussing the conclusions to the research sub-questions, the final conclusion to research question 4 is that competencies in all three of the cognitive, intrapersonal and interpersonal domains were developed, and that transfer of these competencies was observed. It can thus be stated that the empirical results suggest that the implications of implementing the suggested guidelines are that DSDL was developed.

6.4 FINAL CONCLUSIONS OF THE STUDY, AND SUGGESTED GUIDELINES

Learning in the 21st century requires that students be deeper learners and self-directed learners, who take ownership of their learning, who can transfer knowledge, and who have a multitude of 21st-century competencies in the cognitive, intrapersonal and interpersonal domains. In this thesis, DSDL was described as a process revolving around cognitive, intrapersonal and interpersonal competencies, recursively driven by SDL and DL. It was argued that none of the processes of SDL and DL can be excluded when teaching and learning in the 21st century, and it was therefore suggested that DSDL can meet the requirements of 21st-century learning. When strategies to develop DSDL are incorporated in teaching-learning strategies, students will take responsibility for their learning, where the aim is for them to transfer their knowledge to new and unknown situations. Students will view their learning needs in terms of such transferable knowledge, they will formulate their goals accordingly, they will

identify resources and collaborate with others, they will apply critical thinking, they will solve problems, they will evaluate whether appropriate learning goals and transfer of knowledge have been achieved, and they will persist in their learning until their goals have been met.

CL and cooperative pair programming were proposed as possible teaching-learning strategies to develop DSDL. When applying CL or cooperative pair programming as teaching-learning strategies, the aim will accordingly be to instil lifelong learning and develop deeper self-directed learners, who can successfully face the challenges of the 21st century. It was further suggested that CLT, SCT, and strategies to develop transfer of knowledge and to develop SDL should be incorporated in CL to develop DSDL.

The conceptual framework of this study is indicated in Figure 6.9. SDL and DL are mutually driving each other when CL is applied as the teaching-learning strategy and the learning theories of CLT and SCT are incorporated. By integrating these concepts and theories, guidelines for DSDL were developed, for students to ultimately take responsibility for their own learning and develop transferable competencies.

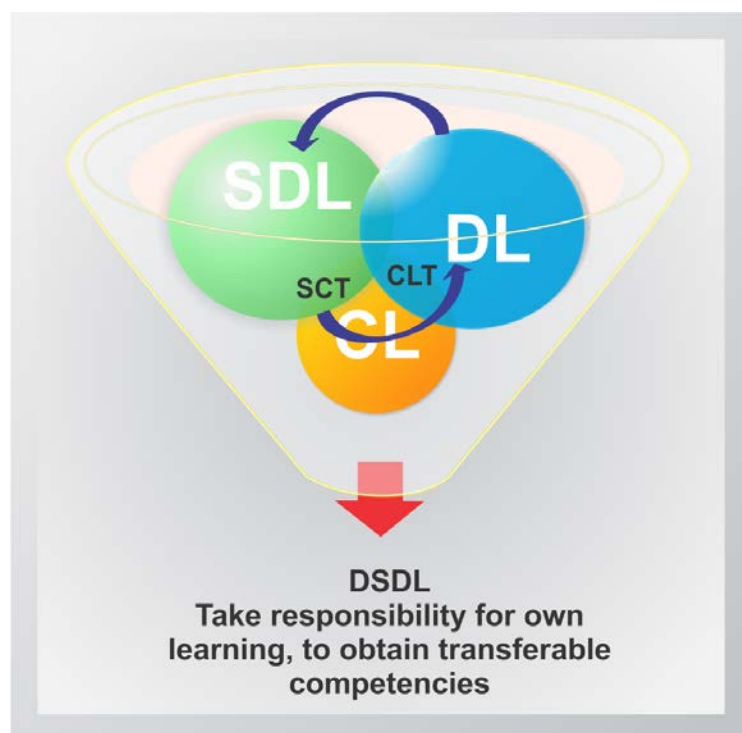


Figure 6.9: DSDL – conceptual and theoretical framework
(Source: own contribution)

Suggested guidelines for DSDL were first implemented in MC1 and were then refined in MC2. Quantitative and qualitative data to determine participants' experiences of the implemented guidelines and the implications of the guidelines on their SDL and transfer of knowledge were analysed after each intervention cycle, and guidelines were adjusted accordingly. Finally,

guidelines were proposed for developing DSDL in a database module in CAT education (see Table 6.1).

The quantitative and the qualitative results suggested that competencies in the cognitive, intrapersonal and interpersonal domains were developed after implementation of the guidelines to develop DSDL. Results further indicated that participants were inclined to apply far transfer and to thus transfer their competencies to new scenarios. The implemented guidelines promoted transfer and improved participants' SDL, thus developing their DSDL.

6.5 LIMITATIONS OF THE STUDY

Guidelines for DSDL were developed for a specific context, namely for a database module in CAT education at a South African higher education institution. The study was done on two consecutive year groups of students, each time consisting of relatively small populations. Data collection was further limited to participants who gave informed consent and who were also willing to take part in completing questionnaires and who accepted invitations to interviews, which limited the size of the study population. Other limitations were that the researcher was also the facilitator of the module, and that no control group could be used.

6.6 RECOMMENDATIONS FOR FURTHER RESEARCH

Although guidelines for DSDL were generically formulated to be applied in any appropriate context, more research is required in larger populations, in other subject areas, and in other disciplines, before the proposed guidelines can be generalised.

It is therefore recommended that further research be conducted on other students at higher education institutions that are enrolled for database design modules in other disciplines, to refine and develop the guidelines and to further establish the validity of this research. It is also recommended that the proposed guidelines for DSDL be implemented and researched in other subject areas where complex tasks have to be learnt, such as mathematics, physical science, and accounting. Research is also recommended where control groups can be incorporated.

Some outcomes of this study require further research. Guidelines can be revised to include more support for students who are less self-directed in their learning. The correlations found between the categories of the SRSSDL and TLO should be investigated further. Although factors that hindered transfer were identified, it does not imply that transfer did not occur. These factors should, however, be addressed in future, to create fertile environments where transfer can be promoted even more. It is also suggested that the reliability of the TLO for larger populations in South African contexts should be determined. A meta-analysis of results of the SRSSDL on small populations is also recommended, to assist in interpreting the results.

6.7 FINAL COMMENTS

In this study it was indicated that specific strategies need to be incorporated in teaching to prepare students for the requirements of the 21st century. Students have to be deeper self-directed learners, who can apply far transfer of competencies and take responsibility for their own learning. A theoretical basis for DSDL was provided, and guidelines to develop DSDL were proposed. Within these guidelines, CLT, SCT and strategies to transfer knowledge were incorporated in CL to provide guidelines to develop DSDL. The results of this study indicate that implementation of the suggested guidelines developed DSDL in a database module in CAT education.

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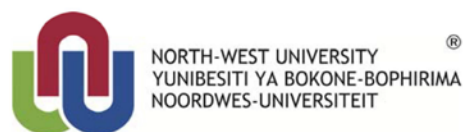
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APPENDIX A: ETHICS APPROVAL



SC van Zyl
Per Email: sukie.vanzyl@nwu.ac.za

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: <http://www.nwu.ac.za>

NWU RDGC PERMISSION GRANTED / DENIED LETTER

Based on the documentation provided by the researcher specified below and after being reviewed at the meeting held on **19/07/2017** the **NWU Research Data Gatekeeper Committee (NWU-RDGC)** hereby grants permission for the specific project (as indicated below) to be conducted at the North-West University (NWU).

Project title: *Developing deeper self-directed learning in Computer Applications Technology education.*

Project leader: Prof E Mentz

Student: SC van Zyl

NWU reference no: NWU-HS-2017-0064

Approval date: 19/07/2017

Expiry date: 19/07/2018

General Conditions of Approval:

- The NWU-RDGC will not take the responsibility to recruit research participants or to gather data on behalf of the researcher. This committee can therefore not guarantee the participation of our relevant stakeholders.
- Any changes to the research protocol within the permission period (for a maximum of 1 year) must be communicated to the NWU-RDGC. Failure to do so will lead to withdrawal of the permission.
- The NWU-RDGC should be provided with a report or document in which the results of said project are disseminated.

Please note that under no circumstances will any personal information of possible research subjects be provided to the researcher by the NWU RDGC. The NWU complies with the Promotion of Access to Information Act 2 of 2000 (PAIA) as well as the Protection of Personal Information Act 4 of 2013 (POPI). For an application to access such information please contact Ms Amanda van der Merwe (018 299 4942) for the relevant enquiry form or more information on how the NWU complies with PAIA and POPI.

The NWU RDGC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the NWU RDGC for any further enquiries or requests for assistance.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'M Verhoef'.

Prof. Marlene Verhoef
Chair: NWU-RDGC

APPENDIX A(a): EXTENSION OF ETHICS APPROVAL



26 June 2018

To Whom It May Concern

I hereby confirm that extension of the period of ethical clearance for the ethics application, as stated below, was approved on the Edu-REC meeting of 22 March 2018.

Ethics number: NWU-HS-2017-0064

Project head: Prof E Mentz

Project team: S van Zyl

Title: Developing deeper self-directed learning in Computer Applications Technology education

Initial period: 19 July 2017 – 19 July 2018

Extended period granted until: 31 March 2019

Extension granted on Edu-REC meeting of 22 March 2018.

Risk level: Low

Should you have further enquiries in this regard, you are welcome to contact Prof Jako Olivier at 018 285 2078 or by email at Jako.Olivier@nwu.ac.za or Ms Erna Greyling at 018 299 4656 or by email at Erna.Greyling@nwu.ac.za.

Yours sincerely

Prof J Olivier
Chair Edu-REC

APPENDIX B: INFORMED CONSENT FORM



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: <http://www.nwu.ac.za>

Computer Science Education
Tel: 0182991472
Email: sukie.vanzyl@nwu.ac.za

INFORMED CONSENT FORM

You are invited to take part in the following research project:

Developing deeper self-directed learning in Computer Applications Technology education

The project leader is Prof. Elsa Mentz (PhD): 018 299 4781, elsa.mentz@nwu.ac.za.

The doctoral student is Mrs Sukie van Zyl (MEd): 018 299 1472, sukie.vanzyl@nwu.ac.za.

The project will be carried out over a period of two years on the Potchefstroom campus of the North-West University (NWU). All students taking the module CATE 321 in 2017 or in 2018 are invited to take part in this project.

The aim of this project will be to determine how deeper self-directed learning can be developed in a database and network module in Computer Applications Technology (CAT) education. This study will inform the teaching–learning practice, to equip students with 21st century competencies.

If you choose to participate in the project, the following will be expected of you:

- To complete a questionnaire at the beginning and at the end of a semester and to complete another two questionnaires during the semester. Each questionnaire should not take you longer than 20 minutes to complete. You will be required to complete the questionnaires in class time, during the contact session for the module CATE 321.
- You may be invited to a focus group interview of approximately 30 minutes.
- You may be invited to an individual interview of approximately 30 minutes.

The questionnaires and interviews will enable the researcher to determine the effectiveness of the teaching–learning strategies used in developing students' deeper self-directed learning, by monitoring students' experience of the teaching–learning strategy. The questionnaires and interviews will also enable the researcher to adjust teaching–learning strategies accordingly.

The questionnaires will be available in both Afrikaans and English.

There are no potential discomfort and/or potential dangers and/or potential permanent consequences in participating in this project.

You may opt out of the project at any time, without being disadvantaged or discriminated against.

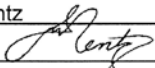
No remuneration for partaking in this project can be expected.

The data will be handled and stored confidentially. The data will only be analysed by the researcher and Statistical Consultation Service of the NWU. Although your student number will appear on the questionnaires it will only be in order to compare your questionnaires with each other and nowhere will your identity be disclosed. Interviews will be recorded on two electronic devices in order to be

transcribed. After being copied to a safe hard disk, the interviews will be deleted from the devices. Your name will not be recorded and no mentioning of names will be done in transcriptions. The transcriptions may be done by another person in a confidential manner. The researcher will store the data in password-protected electronic files for a period of seven years. The researcher, the project head and statistical consultation services will be the only individuals who will have access to the data collected.

The results of the project may be published in accredited academic journals or may be presented at academic conferences. The results of the project can be disclosed to you on request.

As project head, I confirm to participants that the above information is complete and correct.

Prof E Mentz	(Name of project head)
	15 August 2017
Signature of project head	Date
Signed at Potchefstroom	(Place of signature)

It is important that you also read and understand the following general principles, which are applicable to all participants in our project:

1. Participation in the project is completely voluntary and no pressure, however subtle, may be placed on you to take part.
2. It is possible that you may not derive any benefit personally from your participation in the project, although the knowledge that may be gained by means of this project, may benefit other persons or communities.
3. You may not be bribed to participate in the project.
4. You are free to withdraw from the project at any time, without stating reasons, and you will in no way be harmed by doing so. You may also request that your data no longer be used in the project. You are however, kindly requested not to withdraw from the project without careful consideration, since it may have a detrimental effect on the statistical reliability of the project.
5. The NWU Ethics Committee and/or a Court of Law may request access to information to ensure/inspect the ethical responsibility of practices in the interest of participants and the public.
6. You will be given access to your data upon request, unless the Ethics Committee has approved temporary non-disclosure.
7. You are encouraged to ask the Project Head any questions you may have regarding the project and the related procedures at any stage; she will gladly answer your queries. She will also discuss the project with you in detail.
8. If you are a minor, the written consent of your parent or legal guardian is required before you participate in this project, as well as your voluntary assent (in writing if possible) to take part. No coercion may be placed on you.
9. The project objectives are always secondary to your well-being, and actions taken will always place your interests above those of the project.
10. No project may be commenced before it has been approved by the Ethics Committee. Furthermore, the Project Head must report any detrimental effects experienced during the implementation of the project in full and without delay to the chairperson of the Ethics Committee. If any unforeseen serious detrimental effects are observed during the project, it may be necessary to terminate the project immediately.

I, the undersigned _____

full names and surname

have read the preceding premises in connection with the project, as discussed in this informed consent form, and have also heard the oral version thereof and I declare that I understand it.

I give my informed consent to participate in this project. (Draw a cross on the applicable textbox:)

☐ YES

(I give consent)

☐ NO

(I do not give consent)

I have initialled on every page of this informed consent form. I was given the opportunity to discuss relevant aspects of the project and I hereby declare that I am taking part in the project voluntarily.

_____(Name of participant)

Cell number: _____ e-Mail: _____

Signature of participant

Date

Signed at _____(Place of signature)

WITNESSES

_____(Name of witness 1)

Signature of witness 1

Date

Signed at _____(Place of signature)

_____(Name of witness 2)

Signature of witness 2

Date

Signed at _____(Place of signature)

APPENDIX C: INTERVIEW PROTOCOLS

Interview protocol for focus group interviews

Remind the participants about the informed consent forms that they have previously signed and explain issues of anonymity and the recording process of the interview. Ask participants if they are still willing to participate in the project. Ensure participants that they will in no way be disadvantaged and that they may voice their honest opinions regarding questions.

Make sure that both electronic devices are switched on.

Date: _____ Time: _____ Place _____

This interview aims to satisfy research question 4:

4. What are the implications of implementing the suggested guidelines in the CAT class at university?
 - a. What are students' experiences of implementation of these guidelines?
 - b. What is the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills?
 - c. What factors hinder or promote transfer?
 - d. What is the effect of deliberate implementation of the suggested guidelines on students' SDL?

You have been invited to this interview because you did well in your test and indicated that you were able to transfer the concepts learned in this module to other scenarios.

1. How do you prepare yourself for the CATE 321 class?
2. Could you please share the strategy that you followed to prepare yourself for the test with us?
3. Why would you say were you able to do well in this test?
4. How did you experience the teaching-learning strategy that was applied in the module CATE 321?
5. Do you have any suggestions for improving the teaching-learning strategy in the module CATE 321?

Interview protocol for one-on-one interviews

Remind the participant about the informed consent form that he/she signed previously and explain issues of anonymity and the recording process of the interview. Ask the participant if he/she is still willing to participate in the project. Ensure the participant that he/she will in no way be disadvantaged and that the participant may voice his/her honest opinion regarding questions.

Make sure that both electronic devices are switched on.

Date: _____ Time: _____ Place _____

This interview aims to satisfy research question 4:

4. What are the implications of implementing the suggested guidelines in the CAT class at university?
 - a. What are students' experiences of implementation of these guidelines?
 - b. What is the effect of deliberate implementation of the suggested guidelines on transfer of knowledge and skills?
 - c. What factors hinder or promote transfer?
 - d. What is the effect of deliberate implementation of the suggested guidelines on students' SDL?

Interview questions will be based upon the participant's transfer test. Participants that obtained between 0% to 74% for the transfer test, will be invited to one-on-one interviews. The test will also be used in the interview as anchor document to formulate questions regarding the student's thinking and understanding of database concepts.

1. Explain which concepts, if any, did you found difficult to understand in this section of the module that may have influenced your performance.
2. Could you please explain the factors, if any, that hindered your performance?
3. Could you please share the strategy that you followed to prepare yourself for the test?
4. How did you experience the teaching-learning strategy that was applied in the module CATE 321?
5. Do you have any suggestions for improving the teaching-learning strategy in the module CATE 321?
6. Please explain your thinking and understanding of concepts when answering question/questions _____.
(This question will differ from participant to participant according to the results of their transfer test.)

APPENDIX D: THE SELF-RATING SCALE OF SELF-DIRECTED LEARNING (SRSSDL)

Dear student

Research on the improvement of education can be seen as a continuing process and it is a necessity in order to ensure quality teaching and learning at this institution. With this questionnaire we aim to get an overview of your learning and study orientation in order to ensure that our teaching is of high quality. This forms part of a research project that aims to improve teaching strategies. Your participation is non-obligatory and will be anonymous – the student number that you fill in on the multiple-choice form is solely for the purpose of comparing your answers before and after this course. It will not reflect negatively upon you if you decide to participate or not. If you do complete the questionnaire, you give your permission that the data may be used for research purposes.

GENERAL INFORMATION

Student number:

1. Gender

Male	1	Female	2

2. Age

18	1	19	2
20	3	21	4
22 - Older	5		

3. Are you registered for the B.Ed.-degree or the PGCE?

B Ed degree	1	PGCE	2

4. For which phase in the B Ed program are you registered?

Foundation phase	1	Intermediate	2
Senior	3	FET	4

5. Indicate your year group?

First year	1	Second year	2
Third year	3	Fourth year	4

6. Indicate your average percentage of all your subjects in your previous academic year:

40% and lower	1	41%-50%	2
51% - 60%	3	61% - 70%	4
71% - 80%	5	81% and higher	6

7. Expected academic achievement in THIS subject:

40% and lower	1	41%-50%	2
51% - 60%	3	61% - 70%	4
71% - 80%	5	81% and higher	6

Response key: 1 = Never; 2 = seldom; 3 = sometimes; 4 = often; 5 = always						
8	I identify my own learning needs.	1	2	3	4	5
9	I am able to select the best method for my own learning.	1	2	3	4	5
10	I consider teachers as facilitators of learning rather than providing information only.	1	2	3	4	5
11	I keep up to date on different learning resources available.	1	2	3	4	5
12	I am responsible for my own learning.	1	2	3	4	5
13	I am responsible for identifying my areas of deficit.	1	2	3	4	5
14	I am able to maintain self-motivation.	1	2	3	4	5
15	I am able to plan and set my learning goals.	1	2	3	4	5
16	I have a break during long periods of work.	1	2	3	4	5
17	I need to keep my learning routine separate from my other commitments.	1	2	3	4	5
18	I relate my experience with new information.	1	2	3	4	5
19	I feel that I am learning despite not being instructed by a lecturer.	1	2	3	4	5

Response key: 1 = Never; 2 = seldom; 3 = sometimes; 4 = often; 5 = always						
20	I participate in group discussions.	1	2	3	4	5
21	I find peer coaching effective.	1	2	3	4	5
22	I find “role play” is a useful method for complex learning.	1	2	3	4	5
23	I find inter-active teaching and learning sessions more effective than just listening to lecturers.	1	2	3	4	5
24	I find simulation in teaching and learning useful.	1	2	3	4	5
25	I find learning from case studies useful.	1	2	3	4	5
26	My inner drive directs me towards further development and improvement in my learning.	1	2	3	4	5
27	I regard problems as challenges.	1	2	3	4	5
28	I arrange my self-learning routine in such a way that it helps develop a permanent learning culture in my life.	1	2	3	4	5
29	I find concept mapping is an effective method of learning.	1	2	3	4	5
30	I find modern educational interactive technology enhances my learning process.	1	2	3	4	5
31	I am able to decide my own learning strategy.	1	2	3	4	5
32	I rehearse and revise new lessons.	1	2	3	4	5
33	I identify the important points when reading a chapter or an article.	1	2	3	4	5
34	I use concept mapping/outlining as a useful method of comprehending a wide range of information.	1	2	3	4	5
35	I am able to use information technology effectively.	1	2	3	4	5
36	My concentration intensifies and I become more attentive when I read complex study content.	1	2	3	4	5
37	I keep annotated notes or a summary of all my ideas, reflections and new learning.	1	2	3	4	5
38	I enjoy exploring information beyond the prescribed course objectives.	1	2	3	4	5
39	I am able to relate knowledge with practice.	1	2	3	4	5
40	I raise relevant question(s) in teaching-learning sessions.	1	2	3	4	5
41	I am able to analyse and critically reflect on new ideas, information or any learning experiences.	1	2	3	4	5
42	I keep an open mind to others’ point of view.	1	2	3	4	5
43	I prefer to take a break in between learning tasks.	1	2	3	4	5

44	I self-assess before I get feedback from instructors.	1	2	3	4	5
45	I identify the areas for further development in whatever I have accomplished.	1	2	3	4	5
46	I am able to monitor my learning progress.	1	2	3	4	5
47	I am able to identify my areas of strength and weakness.	1	2	3	4	5
48	I appreciate when my work can be peer reviewed.	1	2	3	4	5
49	I find both success and failure inspire me to further learning.	1	2	3	4	5
50	I value criticism as the basis of bringing improvement to my learning.	1	2	3	4	5
51	I monitor whether I have accomplished my learning goals.	1	2	3	4	5
52	I check my portfolio to review my progress.	1	2	3	4	5
53	I review and reflect on my learning activities.	1	2	3	4	5
54	I find new learning challenging.	1	2	3	4	5
55	I am inspired by others' success.	1	2	3	4	5
56	I intend to learn more about other cultures and languages I am frequently exposed to.	1	2	3	4	5
57	I am able to identify my role within a group.	1	2	3	4	5
58	My interaction with others helps me to develop the insight to plan for further learning.	1	2	3	4	5
59	I make use of any opportunities I come across.	1	2	3	4	5
60	I need to share information with others.	1	2	3	4	5
61	I maintain good interpersonal relationships with others.	1	2	3	4	5
62	I find it easy to work in collaboration with others.	1	2	3	4	5
63	I am successful in communicating verbally.	1	2	3	4	5
64	I identify the need for inter-disciplinary links for maintaining social harmony.	1	2	3	4	5
65	I am able to express my ideas effectively in writing.	1	2	3	4	5
66	I am able to express my views freely.	1	2	3	4	5
67	I find it challenging to pursue learning in a culturally diverse milieu.	1	2	3	4	5

APPENDIX E: PERMISSION TO USE THE TRANSFERABLE LEARNING ORIENTATIONS (TLO) TOOL

From: Natalie Simper <nls3@queensu.ca>
To: Sukie Van Zyl <Sukie.VanZyl@nwu.ac.za>
CC: Jake Kaupp <jake.kaupp@queensu.ca>, Brian Frank <brian.frank@queensu.ca>, Jill Scott <scottj@queensu.ca>
Date: 2016/11/10 04:01 PM
Subject: Re: Request for using TLO in research - Transferable Learning Orientations tool
Attachments: ATT00001.bmp

Dear Sukie,

We are pleased to hear of your interest in the TLO, and are happy for you to use it in your research. I am very interested in how the translation into Afrikaans is received by the third year computer technology students. Let me know if you have any follow up questions.

Regards,
Natalie Simper
Assessment Research Project Manager

OFFICE OF THE PROVOST
Queen's University, Mackintosh Corry F203
Kingston, ON | K7L 3N6, Canada
613 533-6000 x77072 natalie.simper@queensu.ca<mailto:natalie.simper@queensu.ca>
<http://www.queensu.ca/qloa/>

From: Sukie Van Zyl <Sukie.VanZyl@nwu.ac.za<mailto:Sukie.VanZyl@nwu.ac.za>>
Date: Thursday, November 10, 2016 at 5:11 AM
To: Natalie Simper <nls3@queensu.ca<mailto:nls3@queensu.ca>>
Subject: Request for using TLO in research - Transferable Learning Orientations tool

Dear Natalie

I have read your article regarding the development of the TLO and hereby request permission to use the TLO in my research.

I am currently busy with my PhD at the North West University, Potchefstroom, South-Africa and some aspects that I am interested in is the development of students' self-direction and transferable knowledge. The population will be third year education students, in the subject Computer Applications Technology.

I also request permission to translate the TLO to Afrikaans.

Yours sincerely

Sukie van Zyl

Subject head Computer Science Education
School of Natural Sciences and Technology (Building B10/G17)
Self-directed Learning / Cooperative Learning
Vakhoof Rekenaarwetenskap-onderwys
Skool vir Natuurwetenskappe en Tegnologie (Gebou B10/G17)
Selfgerigte Leer / Koöperatiewe leer
[cid:AGKFXDHHOHN.R.IMAGE_3.BMP]

Vrywaringklousule / Disclaimer: <http://www.nwu.ac.za/it/gov-man/disclaimer.html>

APPENDIX F: THE TRANSFERABLE LEARNING ORIENTATIONS (TLO) TOOL

Dear Student

Research on the improvement of education can be seen as a continuing process and it is a necessity in order to ensure quality teaching and learning at this institution. With this questionnaire we aim to get an overview of your teaching–learning orientation in order to ensure that our teaching is of high quality. This forms part of a research project that aims to improve teaching strategies. Your participation is non-obligatory and will be anonymous – the student number that you fill in on the multiple-choice form is solely for the purpose of comparing your answers before and after this module. It will not reflect negatively upon you when you decide to participate or not. If you do complete the questionnaire, you give your permission that the data may be used for research purposes.

Student number

Outcome motivation					
Scale: 1 = Not at all like me ----- 5 = Very true of me					
1	I prefer assignments that really challenge me so I can learn from them, even if they do not guarantee a good grade.	1	2	3	4 5
2	Getting a good grade in my course is the most important thing for me right now.	1	2	3	4 5
3	I want to do well in this module because it is important to prove myself to my family, friends, employer, or others.	1	2	3	4 5
4	What is it that personally motivates you in this module? 				
5	Which of the following most accurately describes you? - My main motivation for learning is to avoid letting others down or being seen as a failure. 1 - My main motivation is academic success, but I still enjoy exploring the subject matter. 2 - My motivation to understand the subject matter is as important to me as my academic success. 3 - I am motivated by intense curiosity to understand subject matter; academic success is a secondary concern. 4				

Learning belief						
Scale: 1 = Not at all like me ----- 5 = Very true of me						
6	If I did not succeed in this module, it was because I did not try hard enough.	1	2	3	4	5
7	It is my own fault if I do not learn in this module.	1	2	3	4	5
8	If I can't understand something when it's first introduced, I'm never going to understand it.	1	2	3	4	5
9	If I try hard enough, then I will be able to learn the material in this module.	1	2	3	4	5
10	Reflecting on the way you apply yourself, what control do you believe you had over "factors" affecting your academic achievement? (Examples of "factors": The capability to learn new ideas; the capacity to change the way you think or your approach to learning; the management of time, effort, study techniques, study setting). _____ _____ _____ _____ _____ _____					
11	Which of the following most accurately describes you? (Examples of "factors": ability, approach, effort, technique, time, study setting).					
	• My academic performance is dependent on factors I cannot control.					1
	• I have some control over the factors affecting my academic performance.					2
	• I am adaptable and can control most of the factors affecting my academic performance.					3
	• I am capable of changing my thinking or approach to learning; I have total control over my academic performance.					4

Self-efficacy						
Scale: 1 = Not at all like me ----- 5 = Very true of me						
12	I do not think I have the knowledge or skills necessary to do well in this module.	1	2	3	4	5
13	I am confident I can do an excellent job on assessments in this module.	1	2	3	4	5
14	I am confident I can master the skills associated with this module.	1	2	3	4	5
15	I am certain I can understand the basic concepts taught in this module.	1	2	3	4	5
16	Describe any areas of the module where you lack confidence in tackling. 					
17	1. Which of the following most accurately describes you?					
	I feel tentative about having the knowledge/skills I need to meet the module requirements.					1
	I feel confident that my knowledge/skills are adequate to meet most of the module requirements..					2
	I feel confident that I have the expected level of knowledge/skills to meet all of the module requirements.					3
	I feel very confident that I have all of the necessary knowledge/skills to excel in meeting all of the module requirements.					4

Transfer						
Scale: 1 = Not at all like me ----- 5 = Very true of me						
18	I tried to relate ideas in this module to those in other modules.	1	2	3	4	5
19	When working in this module, I related the material to what I already knew.	1	2	3	4	5
20	In labs or tutorials, I always made connections to concepts covered in readings or lectures.	1	2	3	4	5
21	How did you apply cognitive strategies (perceiving, thinking and remembering) this year? (Strategies may include things like problem solving, repetition, questioning, mnemonics, connecting to prior knowledge).					
22	Which of the following most accurately describes you?					
	• I preferred to memorise key information as it pertained to a specific subject, but sometimes thought about where I had learned similar things.					1
	• I preferred to memorise key information, but also related ideas to what I had learned previously.					2
	• I consistently connected new ideas to what I already know when I applied my knowledge and skills in my modules.					3
	• I made meaningful connections between new and previous learning when I applied knowledge and skills creatively across my modules.					4

Organisation						
Scale: 1 = Not at all like me ----- 5 = Very true of me						
23	I often constructed outlines to help me organise my thoughts..	1	2	3	4	5
24	When studying, I tried to find the most important ideas and/or appropriate process to follow.	1	2	3	4	5
25	I found it hard to stick to a study schedule.	1	2	3	4	5
26	I managed my time well according to my module load.	1	2	3	4	5
27	Describe how you organised your work process for this module. (Organisation may include resource organisation, time management, goal setting, prioritising, adapting plans, organising others). 					
28	Which of the following most accurately describes you?					
	• My organisation was inconsistent; I changed plans regularly to suit my personal needs..					1
	• I tried to organise my work processes, and attempted to structure my study schedules according to deadlines.					2
	• I actively organised my schedules according to my short-term and long-term goals.					3
	• I strategically managed my schedules, and made necessary accommodations in prioritising to meet all of my goals.					4

29	Describe how you experienced the facilitation of the module to date.
30	Describe your experience of the module to date.
31	Which suggestions, if any, can you make to improve the presentation or facilitation of the module?

Beste Student

Navorsing oor onderrigverbetering is 'n deurlopende proses en noodsaaklik om te verseker dat onderrig en leer van hoë gehalte by hierdie instelling plaasvind. Met hierdie vraelys wil ons graag 'n beeld van jou onderrig- en leeroriëntering kry sodat ons kan verseker dat ons onderrig van hoë gehalte lewer. Dit is deel van 'n navorsingprojek wat daarop gemik is om onderrigmetodes te verbeter. Deelname is totaal vrywillig en word anoniem uitgevoer – die studentnommer wat jy op die multikeusevorm invul, is slegs om antwoorde voor en na die module te vergelyk. Jy sal in geen opsig benadeel word indien jy deelneem of besluit om nie deel te neem nie. Indien jy die vraelys invul, gee jy toestemming dat hierdie data vir navorsingsdoeleindes gebruik mag word.

Studentenommer

Motivering as uitkoms													
Skaal: 1 = Glad nie soos ek nie ----- 5 = Baie waar van myself													
1	Ek verkies opdragte wat werklik aan my 'n uitdaging stel sodat ek daaruit kan leer, selfs al sou dit nie 'n goeie punt waarborg nie.	1	2	3	4 5								
2	Om 'n goeie punt in my module te kry is vir my op die oomblik die belangrikste ding.	1	2	3	4 5								
3	Ek wil goed vaar in hierdie module, want dit is belangrik dat ek aan myself en aan my familie, vriende, werkgewer of ander kan bewys waartoe ek in staat is.	1	2	3	4 5								
4	Wat motiveer jou persoonlik in hierdie module? 												
5	Watter van die onderstaande is die akkuraatste beskrywing van jouself? <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>• My belangrikste motivering om te leer is om ander nie in die steek te laat of as 'n mislukking gesien te word nie.</td> <td>1</td> </tr> <tr> <td>• My belangrikste motivering is akademiese sukses, maar ek geniet dit steeds om die vakinhoud verder te ondersoek.</td> <td>2</td> </tr> <tr> <td>• My motivering om die vakinhoud te verstaan is net so belangrik as my akademiese sukses.</td> <td>3</td> </tr> <tr> <td>• Ek word gemotiveer deur intense nuuskierigheid om die vakinhoud te verstaan; akademiese sukses is sekondêr.</td> <td>4</td> </tr> </table>					• My belangrikste motivering om te leer is om ander nie in die steek te laat of as 'n mislukking gesien te word nie.	1	• My belangrikste motivering is akademiese sukses, maar ek geniet dit steeds om die vakinhoud verder te ondersoek.	2	• My motivering om die vakinhoud te verstaan is net so belangrik as my akademiese sukses.	3	• Ek word gemotiveer deur intense nuuskierigheid om die vakinhoud te verstaan; akademiese sukses is sekondêr.	4
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• Ek word gemotiveer deur intense nuuskierigheid om die vakinhoud te verstaan; akademiese sukses is sekondêr.	4												

Leeroortuiging														
Skaal: 1 = Glad nie soos ek nie ----- 5 = Baie waar van myself														
6	As ek nie in die module suksesvol was nie, is dit omdat ek nie my bes gedoen het nie.	1	2	3	4	5								
7	Dit is my eie skuld as ek nie in die module leer nie	1	2	3	4	5								
8	As ek iets wanneer dit die eerste keer bekendgestel word, nie kan verstaan nie, dan gaan ek dit nooit verstaan nie.	1	2	3	4	5								
9	As ek hard genoeg probeer, dan sal dit vir my moontlik wees om die materiaal in die module te leer	1	2	3	4	5								
10	As jy nadink oor die manier waarop jy jouself daarop toegelê het, watter beheer dink jy het jy oor “faktore” gehad wat jou akademiese prestasie beïnvloed het? (Voorbeelde van “faktore”: Die vermoë om nuwe begrippe te leer, die vermoë om die manier waarop jy dink of jou benadering tot leer te verander; tydsbestuur, moeite wat jy doen, studietegnieke, studie-omgewing).													
11	Watter van die onderstaande is die akkuraatste beskrywing van jouself? (Voorbeelde van “faktore”: vermoë, benadering, moeite wat jy doen, tegniek, tyd, studie-omgewing). <table border="1"> <tbody> <tr> <td>• My akademiese prestasie is afhanklik van faktore buite my beheer.</td> <td>1</td> </tr> <tr> <td>• Ek het in 'n mate beheer oor die faktore wat my akademiese prestasie beïnvloed.</td> <td>2</td> </tr> <tr> <td>• Ek is aanpasbaar en kan die meeste van die faktore wat my akademiese prestasie beïnvloed, beheer.</td> <td>3</td> </tr> <tr> <td>• Ek is daartoe in staat om my manier van dink of my benadering tot leer te verander; ek het totale beheer oor my akademiese prestasie.</td> <td>4</td> </tr> </tbody> </table>						• My akademiese prestasie is afhanklik van faktore buite my beheer.	1	• Ek het in 'n mate beheer oor die faktore wat my akademiese prestasie beïnvloed.	2	• Ek is aanpasbaar en kan die meeste van die faktore wat my akademiese prestasie beïnvloed, beheer.	3	• Ek is daartoe in staat om my manier van dink of my benadering tot leer te verander; ek het totale beheer oor my akademiese prestasie.	4
• My akademiese prestasie is afhanklik van faktore buite my beheer.	1													
• Ek het in 'n mate beheer oor die faktore wat my akademiese prestasie beïnvloed.	2													
• Ek is aanpasbaar en kan die meeste van die faktore wat my akademiese prestasie beïnvloed, beheer.	3													
• Ek is daartoe in staat om my manier van dink of my benadering tot leer te verander; ek het totale beheer oor my akademiese prestasie.	4													

Self-doeltreffendheid					
Skaal: 1 = Glad nie soos ek nie ----- 5 = Baie waar van myself					
12	Ek dink nie ek het die kennis of vaardighede wat nodig is om in hierdie module goed te vaar nie.	1	2	3	4 5
13	Ek is vol vertroue dat ek uitmuntend kan vaar tydens assesserings in hierdie module.	1	2	3	4 5
14	Ek is vol vertroue dat ek die vaardighede wat met hierdie module geassosieer word, kan bemeester.	1	2	3	4 5
15	Ek is seker dat ek die basiese begrippe wat in hierdie module onderrig word, kan verstaan	1	2	3	4 5
16	Beskryf enige dele van die module waar jy nie die selfvertroue het om dit aan te pak nie. 				
17	Watter van die onderstaande is die akkuraatste beskrywing van jouself?				
	Ek voel onseker of ek die kennis/vaardighede het wat ek benodig om aan die vereistes van die module te voldoen.				1
	Ek het volle vertroue dat my kennis/vaardighede voldoende is om aan die meeste van die vereistes van die module te voldoen.				2
	Ek het volle vertroue dat ek die verwagte vlak van kennis/vaardighede het om aan al die vereistes van die module te voldoen.				3
	Ek het volle vertroue dat ek al die nodige kennis/vaardighede het om uitmuntend te vaar en aan al die vereistes van die module te voldoen.				4

Oordrag van kennis													
Skaal: 1 = Glad nie soos ek nie ----- 5 = Baie waar van myself													
18	Ek het probeer om idees in hierdie module met die in ander modules in verband te bring.	1	2	3	4	5							
19	Terwyl ek in die module gewerk het, het ek die inhoud met inhoud wat ek reeds ken, in verband gebring.	1	2	3	4	5							
20	In laboratoriums of tutoriale het ek altyd verbande gelê met begrippe wat in leesstukke of lesings behandel is.	1	2	3	4	5							
21	Hoe het jy kognitiewe strategieë (waarneming, denke en memorisering) hierdie jaar toegepas? (Strategieë kan moontlik dinge soos probleemoplossing, herhaling, vraagstelling, geheueleer en aansluiting by voorkennis insluit). 												
22	Watter van die onderstaande is die akkuraatste beskrywing van jouself? <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="padding: 5px;"> - Ek het verkies om sleutelinligting soos op 'n spesifieke vak van toepassing te memoriseer, maar het soms gedink aan soortgelyke dinge wat ek geleer het. </td> <td style="text-align: center; width: 50px;">1</td> </tr> <tr> <td style="padding: 5px;"> - Ek het verkies om sleutelinligting te memoriseer, maar het ook verbande gelê met opvattinge wat ek voorheen geleer het. </td> <td style="text-align: center;">2</td> </tr> <tr> <td style="padding: 5px;"> - Terwyl ek my kennis en vaardighede in my module toegepas het, het ek gedurig nuwe idees gekoppel aan wat ek reeds weet. </td> <td style="text-align: center;">3</td> </tr> <tr> <td style="padding: 5px;"> - Ek het betekenisvolle verbande tussen nuwe en vorige leer gelê toe ek kennis en vaardighede kreatief oor my modules heen toegepas het. </td> <td style="text-align: center;">4</td> </tr> </tbody> </table>					Ek het verkies om sleutelinligting soos op 'n spesifieke vak van toepassing te memoriseer, maar het soms gedink aan soortgelyke dinge wat ek geleer het.	1	Ek het verkies om sleutelinligting te memoriseer, maar het ook verbande gelê met opvattinge wat ek voorheen geleer het.	2	Terwyl ek my kennis en vaardighede in my module toegepas het, het ek gedurig nuwe idees gekoppel aan wat ek reeds weet.	3	Ek het betekenisvolle verbande tussen nuwe en vorige leer gelê toe ek kennis en vaardighede kreatief oor my modules heen toegepas het.	4
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Ek het betekenisvolle verbande tussen nuwe en vorige leer gelê toe ek kennis en vaardighede kreatief oor my modules heen toegepas het.	4												

Organisering						
Skaal: 1 = Glad nie soos ek nie ----- 5 = Baie waar van myself						
23	Ek het gereeld 'n raamwerk opgestel om my te help om my denke te organiseer.	1	2	3	4	5
24	Terwyl ek studeer het, het ek probeer om die belangrikste punte op te spoor en/of om 'n toepaslike proses te volg.	1	2	3	4	5
25	Dit was vir my moeilik om by 'n studierooster te hou.	1	2	3	4	5
26	Ek het my tyd goed bestuur met inagneming van my modulelading.	1	2	3	4	5
27	Beskryf hoe jy jou werkproses vir die module georganiseer het. (Organisering kan insluit: organisering van hulpbronne, tydsbestuur, doelstellings, prioritisering, aanpas van planne, om ander te organiseer). 					
28	Watter van die onderstaande is die akkuraatste beskrywing van jouself?					
	My organisasie het gedurig verander; ek het my planne gereeld verander na gelang van my persoonlike behoeftes.					1
	Ek het probeer om my werksprosesse te organiseer, en het probeer om my studieroosters volgens spertye te organiseer.					2
	Ek het my roosters aktief georganiseer volgens my korttermyn- en langtermyn-doelwitte.					3
	Ek het my roosters strategies bestuur, en die nodige aanpassings gemaak om te prioritiseer en al my doelwitte te behaal.					4

29	Vertel hoe jy die fasilitering van die module tot op hede ervaar het.
30	Beskryf wat jou ervaring van die module tot op hede is.
31	Watter voorstelle, indien enige kan jy maak om die aanbieding of fasilitering van die module te verbeter?

APPENDIX G: FIRST TRANSFER TEST OF THE FIRST MESO-CYCLE

Question 1 [25]

- 1.1 Open the tables Patient and Consultation and study the data carefully. Change the data types and the sizes of fields in the tables to the most suitable types and sizes where necessary. (9)
- 1.2 A consultation refers to one visit of a patient to a dentist. Create a suitable relationship between the tables Patient and Consultation, to represent a real-life relationship. (4)
- 1.3 The table Dentist contains the data of the dentists working at this dentist practice. Improve the table as indicated in the questions below. You do not need to type in any data.
 - 1.3.1 Define a suitable primary key for the table Dentist. (2)
 - 1.3.2 Create a one-to-many relationship between the tables Dentist and Consultation. Add fields if necessary. When you have created the relationship, ensure that it is a representation of a real-life relationship. (5)
 - 1.3.3 Add another two suitable fields of your choice to the table Dentist. Pay attention to the field types. You do not have to enter any data. (5)

Question 2 [25]

Design the following queries. Save the queries according to the question numbers, for example “Query 1”, “Query 2”, etc.

- 2.1 Display all names, surnames and ages of teenage boys that received root channel treatments. Patients between the ages of 12 and 18 (inclusive) are regarded as teenagers. (5)
- 2.2 Display a list of all patients 50 years or older that are members of the medical aids Bonitas or Discovery. The address and town fields must not be displayed. Order the list according to the medical aid name and according to the ages (in ascending order). (5)
- 2.3 Display the titles, names and surnames and the procedures of patients that had teeth extracted during the consultations. The title, name and surname fields must be displayed next to each other, and other fields should not be placed between them. Also, display the date of the extraction, and display the data in the order of date of consultation and then according to surname. (5)
- 2.4 One of the dentists wants to know how many patients from the different towns are visiting the practice. Determine the number of patients per town that are registered on the database. Display only the name of the town and the number of patients per town. The heading “Number of” must be displayed above the column indicating the number of patients per town. Order the data on the number of patients per town in descending order. (5)
- 2.5 Design a cross-tab query to display how many procedures patients received, as well as the types of procedures that were done. The procedures must be displayed as a column heading and the patient numbers as a row heading. (5)

TOTAL: 50

APPENDIX H: SECOND TRANSFER TEST OF THE FIRST MESO-CYCLE

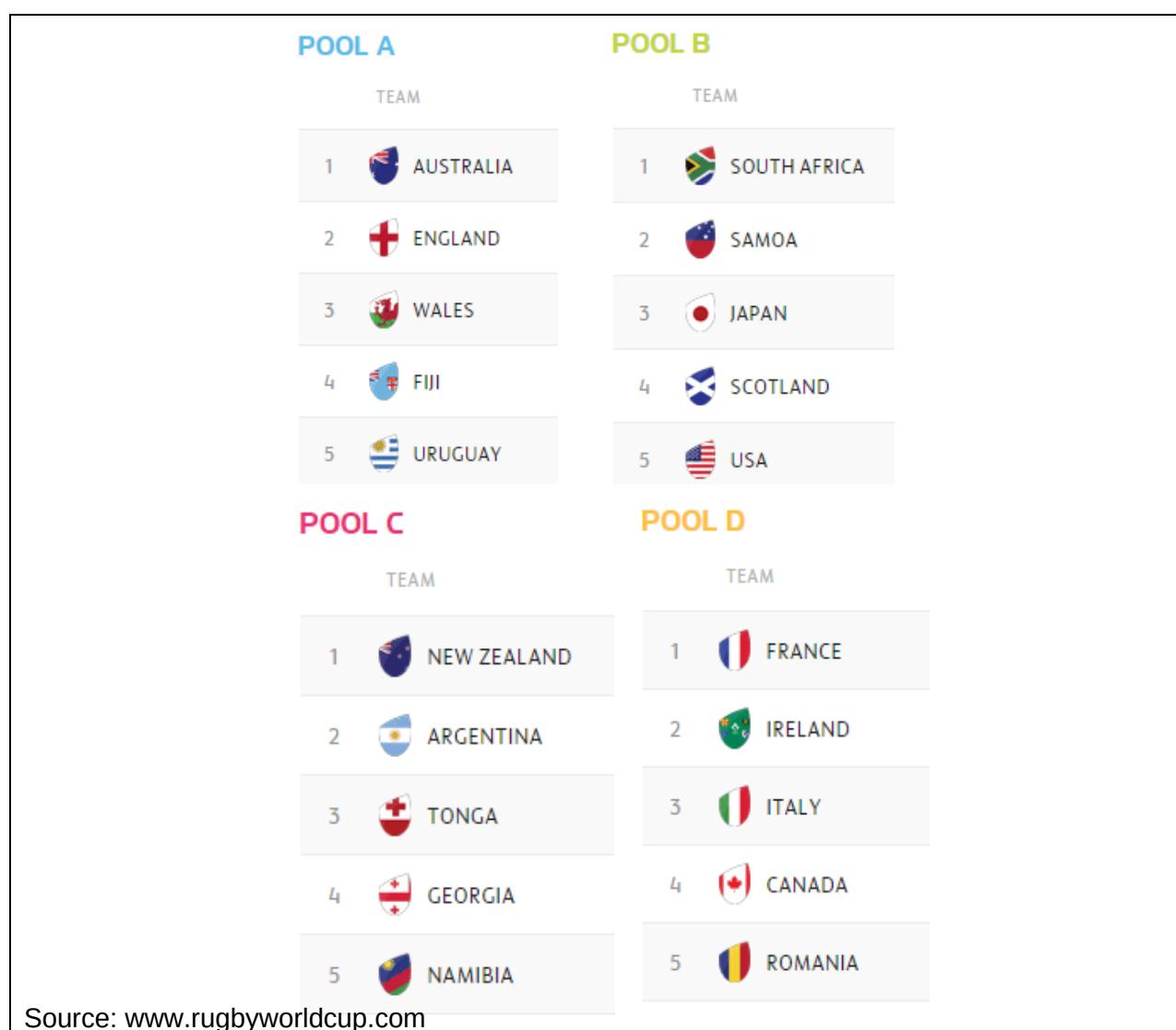
QUESTION 1

[30]

Study the following scenario:

South Africa has to host a World Cup rugby event in 2023 and has to develop a database for this purpose. The team of each country that will take part is divided into a certain pool. In round 1 all the teams in a particular pool will play against each other. The matches will be played at various stadiums in South Africa. Look at how the countries are divided in the different pools (in the diagram below in question 1.1) before you attempt question 1.1.

- 1.1 Do this question in your examination book:
Draw an ER diagram to show the relationships between the entities Match, Pool, Stadium, and Team. The ER diagram should be based on round 1 of the play-offs, which will be played as follows. Each country is divided into a pool. In round 1, countries of the same pool will play against each other. The ER diagram has to be refined, so that no M:N relationships appear. (10)



- 1.2 Do the following question in your examination book:
 Study the table with data of the matches that will be played in round 1 of the World Cup.
 Critically discuss the normalisation of the table. (5)

Stadium ID	Stadium	Number of people that stadium can seat	City	GPS	Pool	Teams	Date of match	Time of match	Ticket price
1	Nelson Mandela	30750	Port Elizabeth	50.8618° N, 0.0833° W	Pool A	Australia & England	2023/07/01	15:00	R 250.00
1	Nelson Mandela	30750	Port Elizabeth	50.8618° N, 0.0833° W	Pool B	USA & Samoa	2023/07/08	18:00	R 250.00
1	Nelson Mandela	30750	Port Elizabeth	50.8618° N, 0.0833° W	Pool C	Namibia & Tonga	2023/07/08	15:00	R 250.00
2	Orlando	40000	Soweto	53.777778, 1.572222	Pool A	Fiji & Uruguay	2023/07/01	18:00	R 300.00
3	Emirates Park	62567	Johannesburg	-33.917669, 18.548055	Pool D	Canada & France	2023/07/04	15:00	R 220.00
3	Emirates Park	62567	Johannesburg	-33.917669, 18.548055	Pool A	Wales & Australia	2023/07/04	18:00	R 220.00
3	Emirates Park	62567	Johannesburg	-33.917669, 18.548055	Pool C	Namibia & Argentina	2023/07/05	15:00	R 220.00
4	Moses Mabhida	54000	Durban	52.6203, -1.14217	Pool A	Uruguay & England	2023/07/05	18:00	R 180.00
5	Newlands	51900	Cape Town	53.482989, -2.200292	Pool A	Wales & Fiji	2023/07/07	15:00	R 270.00
6	Loftus	51762	Pretoria	51.4781° N, 3.1825° W	Pool B	Japan & Samoa	2023/07/07	18:00	R 250.00
7	Peter Mokaba	46000	Polokwane	51.5462° N, 0.0127° W	Pool B	Samoa & Scotland	2023/07/08	15:00	R 200.00
8	Royal Bafokeng	42000	Rustenburg	50.7093° N, 3.4676° W	Pool B	Scotland & USA	2023/07/08	18:00	R 200.00
9	FNB	94700	Johannesburg	54.9756° N, 1.6217° W	Pool B	South Africa & Japan	2023/07/10	15:00	R 300.00
6	Loftus	51762	Pretoria	51.4781° N, 3.1825° W	Pool B	USA & Samoa	2023/07/10	18:00	R 270.00
9	FNB	94700	Johannesburg	51.5558° N, 0.2797° W	Pool C	Argentina & Georgia	2023/07/15	15:00	R 300.00
6	Loftus	51762	Pretoria	51.4781° N, 3.1825° W	Pool C	Georgia & Namibia	2023/07/15	18:00	R 270.00
9	FNB	94700	Johannesburg	51.5558° N, 0.2797° W	Pool C	New Zealand & Argentina	2023/07/16	15:00	R 300.00

- 1.3 Do this question on your computer in Microsoft Access:
Create a normalised database according to the ER diagram that you designed in question 1.1. The table (see question 1.2) contains examples of the data that the database should have. Assign the most correct data types for the fields. You do not have to enter any data in the tables. Save the database as Rugby1_yourstudentnumber. (10)
- 1.4 Do this question on your computer in Microsoft Access:
Create suitable relationships between the tables in the database. (5)

QUESTION 2

[30]

Although rugby players have a favourite position, they do not always play in the same position in all matches. The database Rugby2 needs to keep track of which matches players have played, and what positions they played in the matches. The positions that players play are indicated by specific numbers.

- 2.1 Do this question in your examination book:
The table as given below was suggested by one of the committee members. Discuss the normalisation problem critically. (5)

PlayerName	Position Match1	Match Date1	Position Match2	Match Date2	Position Match3	Match Date3
Cournall Skosan	14	19 Sep	15	26 Sep		
Zane Kirchner			14	26 Sep		
Malcolm Marx			2	26 Sep	11	30 Sep
Francois Louw					8	30 Sep
Lwazi Mvovo	11	19 Sep	13	26 Sep		
Jesse Kriel	12	19 Sep	12	26 Sep	12	30 Sep
Damian de Allende	13	19 Sep			13	30 Sep
Handre Pollard	10	19 Sep			10	30 Sep
Elton Jantjies	15	19 Sep	10	26 Sep	15	30 Sep

- 2.2 Do this question in your examination book:
Identify the entities and draw an ER diagram to represent the data in the above table. The ER diagram has to be refined, so that no M:N relationships appear. (10)
- 2.3 Do this question on your computer in Microsoft Access:
Create a normalised database according to the ER diagram that you designed in question 2.2. The table (see question 2.1) contains examples of the data that the database should have. Choose the most correct data types for the fields. You do not have to enter any data in the tables.
Save the database as Rugby2_yourstudentnumber. (10)
- 2.4 Do this question on your computer in Microsoft Access:
Create suitable relationships between the tables in the database. (5)

TOTAL: 60

APPENDIX I: FIRST TRANSFER TEST OF THE SECOND MESO-CYCLE

Scenario

Rent-a-Car rents vehicles to clients. Their database has to supply information about their clients, vehicles available for renting, and rentals. Loyal customers that have rented a car more than five times receive a rewards card, and they qualify for special discounts on rentals. In most cases clients will make their reservation to hire a car upfront.

Question 1

[33]

- 1.1 Study the data in the table ClientTb.
 - 1.1.1 Add a suitable primary key for the table. (2)
 - 1.1.2 Type in the Word document what the purpose of a primary key in this table is and why you decided on this field. (2)
 - 1.1.3 Change the data types and size of all fields in the table ClientTb to the most suitable types and sizes where necessary. (8)
- 1.2 Study the data on vehicles. Change the data types of the fields to suitable types where necessary, and make the necessary adjustments to ensure that the table fulfils the requirements of good database design. (3)
- 1.3 Create a table RentTb to keep a record of vehicles that are rented out. When a car is rented out, the date on which the vehicle is hired, the date on which the vehicle is returned, the registration number of a vehicle, and a code identifying the client are entered. Decide on your own field names, and create the table according to good design principles. You do not have to type in any data in the table. (8)
- 1.4 Answer this question in the Word document. Describe the real-life relationships that exist in Rent-a-Car between (a) vehicles and rentals and (b) clients and rentals. (4)
- 1.5 Create the relationships as described in question 1.4 in the database. You may make changes to the fields if required. (6)

Question 2

[22]

Design the following queries. Save the queries according to the question numbers, for example Query 1, Query 2, etc.

- 2.1 The manager of Rent-a-Car obtained statistics indicating that car thieves prefer to steal red Kombis or white SUVs. He wants to know which cars in the company have those specifications. Obtain the necessary information from the database, and display the records in a suitable order. (4)
- 2.2 Vehicles have to be replaced at a specific age, and they have to be serviced according to their age. Display the details of all cars that were manufactured in the year as entered by the maintenance manager. Display the records in a suitable order. (3)
- 2.3 The company wants to run a promotion for loyal clients. They want to send out an SMS to clients from Potchefstroom, Klerksdorp, or Stilfontein that are older than 50 years and have a rewards card. Display the necessary information to the marketing manager. (5)

- 2.4 A client wants to rent the same car as before. The client only remembers that the car was a Toyota or a Suzuki and that the number "50" was included in the car's registration number. Design a query to find the car in the database. (4)
- 2.5 Each year stocktaking has to be done on the cars. Create a cross-tab query that displays a summary of the number of vehicles per type and per year that Rent-a-Car owns. Also display the total number of cars per year of manufacturing, with the heading "Total". (6)

Submit the Word document and the database on eFundi.

TOTAL: 55

APPENDIX J: SECOND TRANSFER TEST OF THE SECOND MESO-CYCLE

SECTION A

[20]

Do this section in your answer book.

SCENARIO

Each year the university hostels organise a fundraiser to support students in need. This year they decided to organise a dog show. Owners are encouraged to enter their dogs for as many categories as possible. There is no limit on the number of dogs that an owner can enter. The only prerequisite is that the dog should be at least 4 months old (0.3 years).

Students are responsible for creating a database to handle the administration and the entries.

1. Design an ER diagram to indicate the relationships between the various entities. (8)
2. Give a critical discussion on the normalisation of the following table: (4)

Dog-Name	Owner-Name	Dog-Breed	Gender	Category Entered	Colour	Age
Goliath	Sauncho	Bullmastiff	Male	Dog and owner lookalike; Best condition	Brown	9
Bullet	Albertine	Dalmatian	Female	Best-dressed dog; Prettiest lady; Best condition	Gold	5
Venus	Idaline	Irish Terrier	Female	Waggiest tail	Mahogany	13
Misty	Eve	Boston Terrier	Female	Most handsome dog	Chestnut	4
Codi	Gill	Whippet	Female	Prettiest lady Best condition	Tricolour	5
Shaka	Cleon	Dalmatian	Male	Waggiest tail	Liver	2
Toddy	Ainslee	Yorkshire Terrier	Female	Dog and owner lookalike	Tuxedo	9
Star	Nerty	Boerboel	Female	Waggiest tail; Prettiest lady	Particoloured	8

3. Suggest a normalised solution for the above table. Indicate tables, fields, primary keys, and 1:N connections between the tables. (8)

SECTION B

[60]

Do this section in Microsoft Access.

The database DogShowDB has already been created, and it contains the tables as indicated below:

Table	Purpose of table
DogTb	Contains records about dogs that were entered for the show.
OwnerTb	Contains records about owners that entered their dogs for the show.
CategoryTb	Contains data about the various categories that dogs can be entered in.
DogSpeciesTb	Contains data about various dog species.

4. Assign a suitable primary key for each of the tables DogTb and OwnerTb. (4)
5. Assign suitable field types and sizes to all fields in the DogTb and OwnerTb tables. (5)
6. Adjust the fields as indicated in the table below:

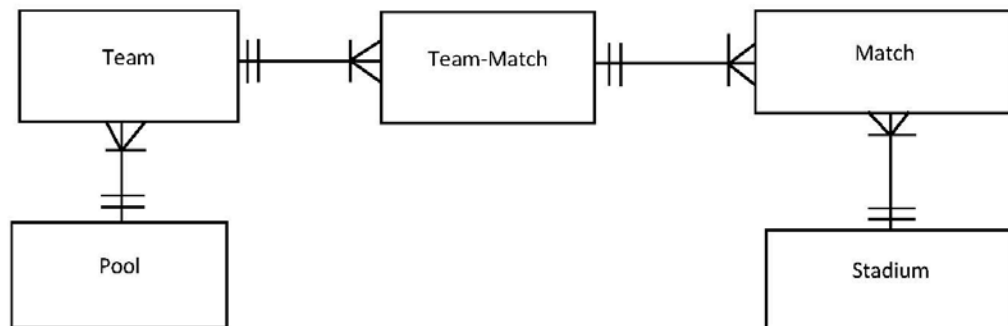
	Field name		
6.1	Species, DogTb	Has to be a lookup field that receives values from table DogSpeciesTb.	(2)
6.2	Age, DogTb	Create a validation rule with an appropriate message. Only values between 0.4 and 16 may be entered.	(2)
6.3	Gender, DogTb	Only the values "M" or "F" may be accepted.	(2)
6.4	CellNo, OwnerTb	Create an input mask that requires 10 digits.	(2)

7. Create a table EntryTb to keep a record of the entries for the various categories. The table must comply with the rules of normalisation. The following fields must be in the table: code for the dog, code for the owner, category that is entered for, and a True/False field indicating if the entry is a winner or not. The primary key must be a combination of applicable fields. You do not have to type any data into the table. (5)
8. Create suitable relationships between all the tables. (8)
9. Create a form "Entry Form" that will allow users to enter data into the table EntryTb. The "category" field must be a combo box that will display details about the categories that dogs can be entered for. (6)
10. Design the following queries as indicated in the table below.

10.1	Display information of all female terrier dogs that are at least 5 years old. The information of their owners should also be displayed. Display the information according to the age.	(5)
10.2	Display the average age of all dog species per species.	(4)
10.3	Display all dogs that are of the colour as requested/entered by the main judge.	(3)
10.4	Change the colour "Buff" to "Blonde" in all applicable records in the table DogTb.	(3)
10.5	Display a summary of all dogs per species and per gender. The number of dogs entered per species and per gender that participate in the dog show has to be displayed in the summary.	(5)
10.6	Display the total income of the dog show fundraiser. Provide the total income with a suitable heading in the query.	(4)

TOTAL: 80

APPENDIX K: EXAMPLE OF AN ENTITY RELATIONSHIP DIAGRAM



APPENDIX L: KNOWLEDGE SURVEYS

Kennisopname LE 7-8 / Knowledge survey SU 7-8

* Required

1. Tik jou studentenommer in / Type in your student number *

2. Ek kan 'n databasis in Access skep. / I can create a database in Access. *

Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./ I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

3. Ek kan tabelle skep en die doel daarvan verduidelik. / I can create tables and explain their purpose. *

Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./ I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

4. Ek kan 'n primêre sleutel skep en die doel van 'n primêre sleutel verduidelik. / I can create a primary key and explain the purpose of a primary key. *

Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./ I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

5. Ek kan relasies skep. / I can create relationships. *

Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./ I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

6. *
Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

7. Ek kan 'n navraag skep en die doel van 'n navraag verduidelik. / I can create a query and explain the purpose of an query. *
Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

8. Ek kan beskryf wat 'n relasionele databasis is. / I can describe what a relational database is. *
Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

9. Ek kan die regte datatipes aan velde toeken. / I can allocate the correct data types to fields. *
Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

10. Ek kan 'n werkblad vanuit Excel na Access invoer (import). / I can import a worksheet from Excel to Access.
Mark only one oval.

1 2 3

Ek het net die vaagste idee hoe om dit te doen
nie./I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak
goed voltooi./I can
complete this task
well.

11. Ek het al begin voorberei vir die toets. / I have already started to prepare for the test. *
Mark only one oval.

☐ Ja/Yes
☐ Nee/No

Kennisopname LE 7-11 Knowledge survey SU 7-11

* Required

1. Tik jou studentenommer in / Type in your student number *

2. Ek kan 'n tabel na 1e normaalvorm normaliseer. / I can normalise a table to 1st normal form. *

Mark only one oval.

1 2 3

Ek het slegs 'n vae idee hoe om dit te doen nie. / I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak goed voltooi. / I can complete this task well.

3. Ek kan 'n tabel na 2e normaalvorm normaliseer. / I can normalise a table to 2nd normal form. *

Mark only one oval.

1 2 3

Ek het slegs 'n vae idee hoe om dit te doen nie. / I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak goed voltooi. / I can complete this task well.

4. Ek kan 'n tabel na 3e normaalvorm normaliseer. / I can normalise a table to 3rd normal form. *

Mark only one oval.

1 2 3

Ek het slegs 'n vae idee hoe om dit te doen nie. / I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak goed voltooi. / I can complete this task well.

5. Ek kan 'n ER-diagram vir 'n scenario opstel. / I can set up an ER diagram for a scenario. *

Mark only one oval.

1 2 3

Ek het slegs 'n vae idee hoe om dit te doen nie. / I have only the faintest idea how to do this.

☐ ☐ ☐

Ek kan hierdie taak goed voltooi. / I can complete this task well.

6. Ek kan 'n input mask vir 'n veld opstel. / I can set up an input mask for a field. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

7. Ek kan 'n valideringsreël vir 'n veld opstel. / I can set up a validation rule for a field. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

8. Ek kan die verskil tussen 'n input mask en valideringsreël verduidelik. / I can explain the difference between an input mask and a validation rule. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

9. Ek kan 'n "lookup"-veld opstel. / I can set up a lookup field. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

10. Ek kan onderskei tussen verskillende veldtipes en groottes. / I can distinguish between various field types and sizes. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

11. Ek kan 'n parameter-query opstel. / I can set up a parameter query. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

12. Ek kan 'n formule in 'n navraag opstel. / I can set up a formula in a query. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

13. Ek kan 'n groepering in 'n navraag doen en die gemiddeld bereken. / I can do grouping in a query and calculate the average. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

14. Ek kan 'n "update"- of "delete" navraag ontwerp. / I can design an update or delete query. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

15. Ek kan 'n "combo box" veld in 'n vorm opstel. / I can set up a combo box field in a form. *

Mark only one oval.

	1	2	3	
Ek het slegs 'n vae idee hoe om dit te doen nie./ I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

16. Ek kan 'n primêre sleutel skep en die doel van 'n primêre sleutel verduidelik. / I can create a primary key and explain the purpose of a primary key. *

Mark only one oval.

	1	2	3	
Ek het net die vaagste idee hoe om dit te doen nie./I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

17. Ek kan verwantskappe tussen tabelle opstel. / I can create relationships between tables. *

Mark only one oval.

	1	2	3	
Ek het net die vaagste idee hoe om dit te doen nie./I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

18. Ek verstaan hoekom verwantskappe tussen tabelle opgestel moet word. / I understand why relationships between tables have to be compiled. *

Mark only one oval.

	1	2	3	
Ek het net die vaagste idee hoe om dit te doen nie./I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

19. Ek kan beskryf wat 'n relasionele databasis is. / I can describe what a relational database is. *

Mark only one oval.

	1	2	3	
Ek het net die vaagste idee hoe om dit te doen nie./I have only the faintest idea how to do this.	☐	☐	☐	Ek kan hierdie taak goed voltooi./I can complete this task well.

20. Ek het al begin voorberei vir die toets. / I have already started to prepare for the test. *

Mark only one oval.

- ☐ Ja/Yes
☐ Nee/No

APPENDIX M: COOPERATION SCRIPTS

Class assignment: Relationships

Open the database Athletics2018-08-08.

Explain the relationships between the tables AthleteTB and TeamTB.

Complete the following:

- One team has...
- One athlete belongs to...

Compile a 1:N relationship between AthleteTB and TeamTB.

- Verify that there is a connection field (Primary key [in one table] and a foreign key [in another table])
- Verify that the data types and sizes of primary and foreign keys are identical. If not, change that of the foreign key. (Why not that of the primary key?).

Study the document on data types given to you.

- Pay attention to the various numeric types.
- Pay attention to other types.

Open table ItemTB in design view (right click on the table).

Change each field type to a suitable data type and size.

Change ItemID to a primary key. (Why?)

Complete the following:

Field	Data type	Size
ItemID		
ItemName		
ItemGender		
ItemTime		
ItemDate		
ItemType		



Change roles

Open table TeamTB in design view (right click on the table).

Change each field type to a suitable type and size.

Change ItemID to a primary key. (Why?)

Complete the following:

Field	Data type	Size
TeamID		
Country		
TeamManager		
TeamManager- ContactNo		
TeamYear		

How did you experience the assignment? What did you experience as difficult?

What did you learn today?

How can you as a group improve? Did all group members take part and contributed? Why not?

Class assignment: Problem solving relationships and queries

Activity 1: Relationships

Open the database ClassDB. The database was designed to provide information on students, lecturers and modules.

1. In table StudentTb : Improve the data types of the fields in the table and assign an appropriate primary key.
2. Compile a 1:N relationship between ProvinceTb and StudentTb. Write down any problems that you experience and your solutions to the problem. (Tip: The primary key of the one table has to link to the foreign key of the other table. The field sizes of the two fields that you want to link have to be exactly the same. Remember to click on “enforce referential integrity”.)

3. Create a table ModuleTb. (Click on Create, Table, right click on Table1 and click op Design View. Rename the table to ModuleTb). The table must contain data of modules that students can take. You have to decide which fields to add to table ModuleTb. Keep the following in mind:
(a) There must be a primary key.
(b) There must be a field that can link to table StudentModule with a 1:N relationship.

4. Type in a few records in table ModuleTb.

Change roles



5. What is the purpose of table StudentModuleTb?

6. Create a compound primary key for StudentModuleTb.
7. Compile a 1:N relationship between table StudentTb and table StudentModuleTb (click on tools relationships). (Tip: The primary key of the one table has to link to the foreign key of the other table. The field sizes of the two fields that you want to link have to be exactly the same. Remember to click on “enforce referential integrity”.)
8. Write down all problems and their solutions that you experienced with question 6.

Change roles



Activity 2: Queries

Create the following queries (Click on create, query design). Save the queries as Query1, Query2, etc.

1. Display the details of all students from KZN and Gauteng.
2. Display all male students that have the letters "co" in their names.
3. Display students who's surnames start with the letters "A" to "D", in alphabetic order, according to surnames

Change roles



4. Display the names, surnames, student numbers, module code and marks of students that obtained less than 50%.
5. Display the details of the student with student number as entered by the user.
6. Display the details of all students who were born between the years 1990 and 2000 (both included).
7. Display the details of the students and their module codes whose marks have not been entered yet.

Reflection on activity 2

Group processing:
<i>How did your group perform on today's activities and list possible reasons for your answer.</i>
<i>How can you improve? What can you do better next time?</i>

Thank your group member for his/her contribution today (be specific)!



APPENDIX N: GUIDELINES TO DEVELOP DSDL IN A DATABASE IN CAT EDUCATION

Guideline no.	Guideline (Table 4.2 and Table 4.3)	Description of guideline	SDL	Cognitive	Intrapersonal	Interpersonal	Transfer	CLT	SCT
1	O, X, Y	Restructure course content for a holistic approach and to revise material. Revisit topics at a deeper level. Provide repeated experience with the same information but in different contexts.		✓			✓	✓	
2	B	Match the level of SDL required to students' level of readiness, and make progression towards student-directed learning over a period of time.	✓	✓	✓	✓			
3	A, D, E, J, K, M	Apply CL or cooperative pair programming as teaching-learning strategies, and include the five essential elements of CL. The roles of navigator and driver are swapped at specific time intervals indicated by the facilitator.	✓	✓	✓	✓	✓	✓	✓
4	AE	Students are assigned randomly to groups by the facilitator to form heterogeneous formal or informal groups. Groups should be limited to four members.	✓	✓	✓	✓		✓	✓
5	W, D	Aim for mastery-approach goals, such as focusing on developing competence and attaining skills, rather than performance goals, by fostering positive interdependence within the groups.	✓	✓	✓	✓	✓		✓
6	AD	Focus on guiding students through inquiry activities first and do some problem-solving, instead of following a tell-first approach.	✓	✓	✓	✓	✓	✓	✓
7	AF	Introduce collaboration scripts to inexperienced groups initially. Care should be taken not to allow collaboration scripts to distract learners' attention and thus limit deep processing of content. In collaboration scripts, indicate when to swop roles. The driver operates the computer, and the navigator brainstorms with the driver to obtain solutions and writes answers on collaboration scripts.	✓	✓	✓	✓	✓	✓	✓
8	F, G	Encourage students to ask essential questions, and cultivate the habit of asking good questions.	✓	✓	✓	✓	✓		

Guideline no.	Guideline (Table 4.2 and Table 4.3)	Description of guideline	SDL	Cognitive	Intrapersonal	Interpersonal	Transfer	CLT	SCT
9	C	Incorporate complex tasks.		✓	✓	✓	✓	✓	
10	H, P, Q, R, AA, AB, AC	Provide students with worked-out examples, progressing in complexity. Examples must focus on real-life scenarios. Include unsolved problems and incorrect solutions to problems, to be discussed critically and debated in groups to incorporate constructive controversy.	✓	✓	✓	✓	✓	✓	✓
11	Z	Follow a whole-part approach for learning tasks, and order learning tasks in task classes.		✓			✓	✓	
12	L	Include metacognitive questioning.	✓	✓	✓		✓		
13	I	Administer knowledge surveys to students.	✓	✓	✓			✓	
14	S	Provide limited feedback and guidance to learning tasks by the facilitator. Structure learning tasks in task classes.	✓	✓			✓	✓	
15	T	During the group discussion, provide feedback on overzealous transfer.		✓	✓	✓	✓	✓	✓
16	C, N, AA	Give a variety of real-life, complex problems on various scenarios, to assist learners in recognising deep-structure similarities in problem scenarios, to develop far transfer. Focus on comparing and contrasting examples, to identify deep-structure similarities.	✓	✓	✓		✓	✓	
17	U, V	Design and do an authentic task as a database project.	✓	✓	✓	✓	✓	✓	

APPENDIX O: CERTIFICATE OF LANGUAGE EDITING DECLARATION

ANTHONY SPARG Freelance language practitioner MA <i>cum laude</i> (African Languages - IsiXhosa), MA <i>cum laude</i> (Linguistics) <i>English language editing, isiXhosa-English and Afrikaans-English translation, and transcription</i> 14 Nahoon Valley Place Nahoon Valley East London, 5241 South Africa Tel.: +27 43 735 4397 Cell: +27 79 106 8179 Email: p.a.sparg@telkomsa.net 4 September 2019 To whom it may concern LANGUAGE EDITING DECLARATION I, Anthony Edward Sparg, freelance language practitioner, hereby declare that I language-edited the PhD thesis titled "Developing deeper self-directed learning in Computer Applications Technology education" for Sukie van Zyl. Thank you. Yours sincerely  Anthony Edward Sparg