Synopsis, Conclusions, Framework for Technology Enhanced Learning at the School of Continuing Teacher Education at North-West University and Recommendations

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1. Introduction

This study determined the prominent aspects on the integration of Technology Enhanced Learning (TEL) in open distance learning (ODL) at the School of Continuing Teacher Education (SCTE), North-West University (NWU), and how to address these aspects in a socially transformative people-centred learning technology integration framework. Figure 7 in the Introduction Chapter of this study refers to the *Context, Framework Requirements* and *Design* of the study. Referring to an adapted Design-Based Research (DBR) approach (Plomp, 2007; Van den Akker *et al.*, 2006), five *Design Cycles* each addressed one of the research sub-questions, while the main Research Question was addressed through combining the five DBR cycles to create one macro DBR cycle.

2. Addressing the Research Question

For convenience of readers, the main Research Question is repeated.

Which aspects will be prominent in a framework for the integration of technology enhanced learning at the North-West University, and how should they be addressed?

The researcher focuses the concatenation of the findings of this research study specifically in the format of a research framework for the integration of learning technologies in ODL at NWU as applicable. Participants in this research, as well as literature, agree that it is imperative to expand e-learning use at SCTE NWU as a result of the importance of TEL in ODL. Table 1 in the Introduction Chapter provides perspective on the five research papers comprising this study in relation to the five research sub-questions.

3. Synopsis

The main Research Question presents itself in two parts:

(i) Which aspects are prominent in a framework for the integration of TEL at NWU?

(ii) How should they be addressed?

A DBR cycle addresses each of the five sub-questions and at the same time attends to the two parts of the main question, progressively shifting the focus from the first to the second part. The first sub-question focusses mainly on part (i), while the last sub-question focusses more on part (ii).

3.1. Addressing Sub-Questions

3.1.1. Sub-Question (a)

> Which aspects should be considered during the process of developing a framework for the integration of TEL at the SCTE?

The context of the study necessitates addressing societal inequality with a special focus on human capital development through education; consequently promotion of teacher quality is of paramount importance. As practising teachers, SCTE students' perspectives are crucial when attempting TEL integration. The first aspect prominent in the TEL integration framework would thus be SCTE NWU students, consisting of around 24 000 practising teachers living and working in all nine provinces of South Africa and in Namibia; studying to obtain or improve their professional qualifications. The second aspect is thirty seven lecturers (faculty members) at SCTE, NWU who develop study material, provide support and perform assessment to train SCTE NWU students through an ODL model. They are assisted by approximately 350 facilitators at 39 learning centres across South Africa and Namibia. The third aspect is the university as an institution, with its particular vision for teaching and learning. An *Initial Framework* evolved through an adapted DBR process, working in close collaboration with participants, and analysis of responses to survey questions, interviews and observations. The first research paper comprising this study mentioned seven aspects and suggested interventions and goals to move each from a pre-existing status to a transformed status. It was a result of analysis and pragmatic interpretation and contained prominent aspects and valid suggestions of interventions. Some of these interventions had to be implemented urgently, which necessitated performing research and development simultaneously (Barab & Squire, 2004), using DBR research approaches in educational technology research (Herrington *et al.*, 2007; Reeves, 2006). The process of DBR research approaches in educational technology research is summarised as:

- Analysis of practical problems in close collaboration with practitioners
- Developing solutions, iterative cycles of testing and refinement of solutions in practice

- Reflection to produce design principles and enhance solution implementation
- Refinement of problems, solutions, methods, and design principles.

In the beginning of 2011, the e-learning manager applied some urgent interventions relating to SCTE lecturers and technology. These were possible as a result of having only internal preconditions which were not time dependent. Preconditions to interventions for effecting social transformation towards TEL integration are external if SCTE does not have resources readily available to intervene immediately. In the case of internal precondition factors, intervention is immediately possible without dependence on resources or additional empowerment from outside SCTE. Time dependent preconditions relate to processes required before socially transformative interventions could be initiated:

> Examples of external preconditions may involve requesting adequate instructional design assistance from the institution for all 37 SCTE lecturers, or requesting sufficient Internet connectivity and provision of open Wi-Fi access to students at the 39 regional support centres. Such interventions cannot be undertaken without elaborate motivation and university management approval. Possibilities of government initiatives or private sector cooperation through investment in furthering teacher training for development may provide Internet connectivity at regional centres, again dependent on external preconditions. Time dependent preconditions may involve processes of consultation and approval regarding external preconditions, or on the other hand could be related to time required for other interventions to bear fruit. Development of e-Maturity may require considerable time. Training is time dependent and must progress in phases where hands-on experience implemented in real application may generate need for more experience as a result of trial and error. In some instances, no interventions may be required and a condition may improve by itself, given enough time (Esterhuizen & Blignaut, 2012).

Urgent interventions required in relation to SCTE lecturers:

- Building lecturers' trust and self-confidence when using computers
- Promoting lecturers' accomplishment in technology use through interaction in a non-threatening environment during hands-on training in group settings with colleagues
- Introducing lecturers to skills in controlling computer applications using electronic interactive whiteboards (IWBs)
- Providing practice in combining IWB use and communicating with students and facilitators at a distance
- Cultivating lecturers' confidence in building a collaborative and interactive environment in synchronous computer mediated conferencing.

Urgent interventions required in relation to technology:

- Verification of People-Technology interaction in practice: Obtaining information on aspects hampering optimum utilisation of technology during hands-on use
- Establishing reliability of technologies during actual use and implementing steps to augment redundancy measures to improve reliability
- Optimising technology performance, using alternative and additional hardware and software and tweaking settings.

The aspects under consideration and the required interventions resulting in the initial framework produced solutions, methods, and design principles utilised in subsequent DBR cycles. In this way, all identified aspects on the list were verified and relationships informed.

Upon reflection to produce *Design Principles* and *Enhance Solution Implementation* according to Figure 6 (Herrington *et al.*, 2007; Reeves, 2006) in the introductory chapter of this study, the researcher contemplated expanding the framework to consider more aspects. In medium term and long term approaches, diverse TEL integration requirements may render obsolete some aspects or the suggested ways in which they were to be addressed in the initial framework. Aspects of the SCTE context during 2011 may not be applicable in the medium and long term. For this reason the researcher used prevalent aspects in the analysis and findings of the next three research papers in this study, and the related DBR cycles to contribute to the development of a *General Approach* included in the emergent TEL framework presented as paper five in this study. Thus, the list of prominent aspects included in the first paper is not comprehensive. The researcher expects that a list of prominent aspects will continue to grow and evolve during future DBR cycles following this study, as will be the case with required interventions and states of transformation in a continuously evolving framework for TEL integration. The *Initial Framework*, included as the first research paper in this study (Esterhuizen & Blignaut, 2011) and intended to address Sub-Question (a), is superseded by the *Integrated TEL Framework,* addressing Sub-Question (e) and the focus of research paper five included in this study (Esterhuizen & Blignaut, 2012). There, the differentiation of categories of intervention is described under § 3.1.5.

3.1.2. Sub-Question (b)

> What significance and implications do perceptions of technophobia, technological disadvantage, ease of use and usefulness of computers have amongst SCTE NWU ODL students who have difficulty in attaining computer literacy?

To address this sub-question, the focus was on SCTE students experiencing difficulty in computer use. Sub-Question (b) was addressed through the second DBR cycle: *Student Computer Literacy Analysis*, as shown in Figure 5 in the Introduction Chapter of this study. The study sample relates to an availability sample of 338 teacher-students who required only one module, computer-literacy, to complete their various qualifications.

3.1.2.1. Significance of technophobia

When combining *strongly agree* and *agree* responses of five-point Likert scale responses, 4.9% declared themselves afraid of computers. This appears to indicate that expectations of technophobia amongst these SCTE students who had difficulty in passing the module on computer literacy were overrated. However, combining *strongly agree* and *agree* responses, 55.2% indicated that they usually need assistance while using computers. Probing the responses on open-ended questions in the survey revealed indications of latent technophobia. While quantitative analysis might indicate low prevalence of technophobia, subsequent qualitative analysis confirmed significant technophobia as is illustrated in the third research paper presented in this study (Esterhuizen *et al.*, 2012c).

3.1.2.2. Significance of Technological Disadvantage

Only 23.3% respondents strongly agree that they have easy access to a computer and only 9.2% indicated easy access to a reliable Internet connection. Combining *strongly agree* and *agree* responses, about 60% of the teacher-students indicated access to a computer, while less than a third of the respondents (29.1%) indicated access to a reliable Internet connection. This is a vivid reminder of conditions of the technological disadvantage in many communities in Southern Africa amongst practising teachers improving their qualifications. It also illustrates the urgency of drastic interventions needed to facilitate TEL adoption. Interventions to alleviate restrictions from the perspective of *Access and Connectivity* may be subject to external preconditions as well as internal preconditions, both of which could be time dependent.

In the research papers included in this study, technological disadvantage features as a prominent theme (Esterhuizen & Blignaut, 2011; Esterhuizen & Blignaut, 2012; Esterhuizen *et al.*, 2012a; Esterhuizen *et al.*, 2012b; Esterhuizen *et al.*, 2012c).

3.1.2.3. Significance of Perceived Ease of Use and Usefulness

Referring to the Technology Acceptance Model (TAM) (Davis *et al.*, 1989), where *Perceived Ease of Use* and *Perceived Usefulness* influences *Behavioural Intention to Use,* analysis of the responses of the sample indicated an overwhelming majority already expressing the *Intention to Use* right from the start. The implications are that possible interventions need not focus on cultivating the *Intention to Use* with participants. The question should rather be what interventions will be needed to adopt technology use within an established intention, but an apparent failure to attempt and persevere towards competence.

3.1.2.4. Implications

The paper suggests a "Model for Intention to Use, Confidence, Trust and Perseverance with Statistical Significant Standardised Regression Weights" (Esterhuizen *et al.*, 2012b). A simplified version of the model is shown below, depicting the relationship between *Intention to Use, Trust to Attempt*, *Self-Confidence* and *Persevere to Attain*. The requirements of *Support* and an *Enabling Environment* to obtain *Self-Confidence* in order to *Persevere to Attain* competence in technology use is indicated in this version (Figure 1).

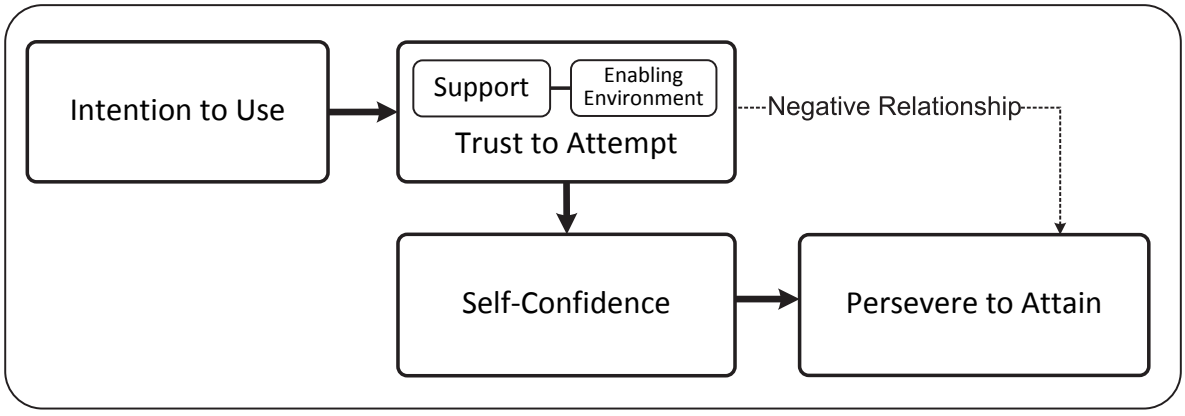


Figure 1: Model for Requirements to Persevere in Attaining Computer Literacy Competence

The implications are that for the sample used, *Support* and an *Enabling Environment* are requirements for participants to have *Trust to Attempt* in order to build *Self-Confidence.* From the attendees of additional computer literacy training sessions surveyed, an

overwhelming majority declared that they look forward to using computers better; while 94% consider computers useful for everyday life and 78.5% believe their learners may benefit from using computers. Strong intentions of perseverance in attaining functional computer literacy are evident, with 95.1% thinking computers will make their work easier if they are better skilled. The research paper names the following limitations:

> Limitations of this study relate to the sample which may represent a single bounded case that is not generalizable to the population of teachers studying further in South Africa. Future research should focus on objective e-competence measurement after support initiatives as recommended in the proposed learning technology integration framework of which this article is part had been implemented. However, this article informs the framework that SCTE should focus on support and enablement (Esterhuizen *et al.*, 2012b).

Implications are that support and an enabling environment might provide even these students the necessary trust to attempt using computers. The cultivated self-confidence from such participation in computer-mediated ODL could build perseverance to attain competence. The implications for the learners at the schools where they teach are that teachers with attained computer literacy and confidence could contribute to the empowerment of their learners. For the learners, this may hold possibilities of collaboration with learners and teachers locally and across the globe, cultivated information literacy competencies, improved study methods and participation in the knowledge economy.

3.1.3. Sub-Question (c)

How do SCTE NWU ODL students react when confronted with technology?

As mentioned above, quantitative analysis showed that the researcher's expectations of technophobia among the students in the sample used above appeared overrated. However, qualitative analysis of the open-ended responses indicated the possibility of a deeper dimension relating to their affective reactions. This prompted the researcher to initiate another adapted DBR cycle of inquiry into the affective reactions of the students in the sample when confronted with technology. The third research paper included in this study: "Computer Literacy Learning Emotions of ODL Teacher-Students" (Esterhuizen *et al.*, 2012c), reports on this research activity. The paper addresses the affective human experiences in terms of the emotions of the students in the sample above while attaining computer competencies for teaching and learning, and for ODL. The paper suggests a two-dimensional "Model for Computer Literacy Learning Emotions," shown here with the percentages of students of the sample in each quadrant (Figure 2).

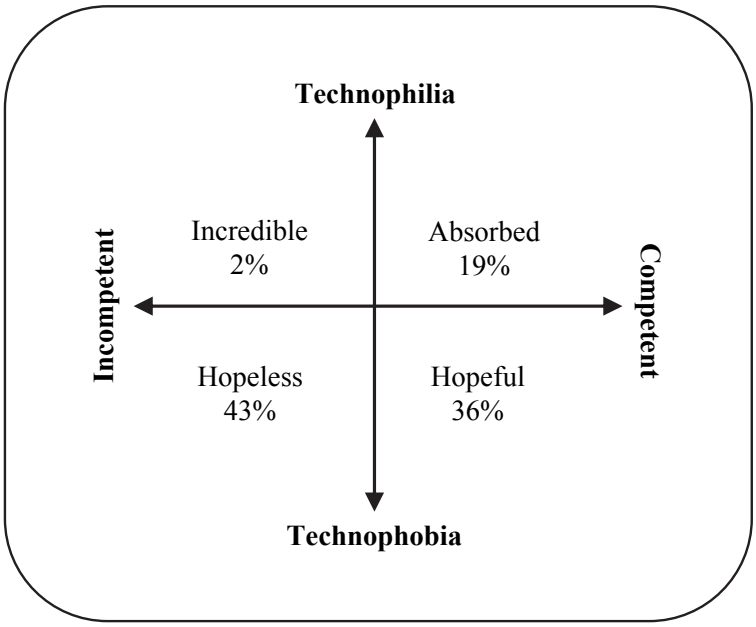


Figure 2: Model for Computer Literacy Learning Emotions

(Esterhuizen *et al.*, 2012c)

The implications are that the majority (79%) may be classified as technophobic (fearful of technology) by adding the percentages of *Hopeless* and *Hopeful* and only 21% may be classified under technophilia (loving technology). Perceptions of 45% show themselves less than competent, while 55% consider themselves competent in using computers. Pro-active interventions are needed to focus on initial objective assessment of computer literacy, followed by custom made ICT training for meaningful implementation of ODL to alleviate technophobia and promote engagement in utilising computers and appropriate learning technologies. Consequential interventions must include introducing teacher students to learner management systems, online libraries, electronic information searching, applicable online study methods, as well as basic academic reading and writing competencies. Students in the sample consider menial activities such as switching on a computer and using a mouse to navigate as representing computer literacy. Computer literacy as part of established acquired skills should be cultivated through curriculum integration and not only through stand-alone computer courses divorced from everyday activities using computers. Once an acceptable level of computer literacy has been established, technological acceptance should enable some online and other interactive media alternatives such as mobile learning. Progressive integration of technology into teaching and learning could develop together with e-readiness for the older generation of teachers as SCTE students. Young teacher-students may require less custom made intervention relating to digital literacy, but will benefit from technology use integrated into the curriculum. This DBR cycle informed the framework for the integration of TEL concerning the importance of support

through an enabling environment as preconditions to building trust to attempt using technology. The fifth paper included in this study (Esterhuizen & Blignaut, 2012), emphasises support in living and learning with technology in a pre-emptive unobtrusive fashion. Labelled *Seamless Support*, it contrasts with *interventions*, which may have top-down drastic action characteristics. The recommendations of this the third research paper (Esterhuizen *et al.*, 2012b) should be informed by the emphasis on pre-emptive *Seamless Support*, as described under § 3.1.5.

3.1.4. Sub-Question (d)

> What do SCTE NWU lecturers' perceptions of the environment in which they have to address the realities of adopting technology enhanced learning (TEL) imply?

A pragmatic approach guided the bounded case study in addressing this sub-question to understand the lived experiences of faculty at a developing ODL unit. This adapted DBR cycle of data gathering, intervention and evaluation succeed the previous cycles in which emerging themes initiated further data gathering cycles towards a TEL integration framework.

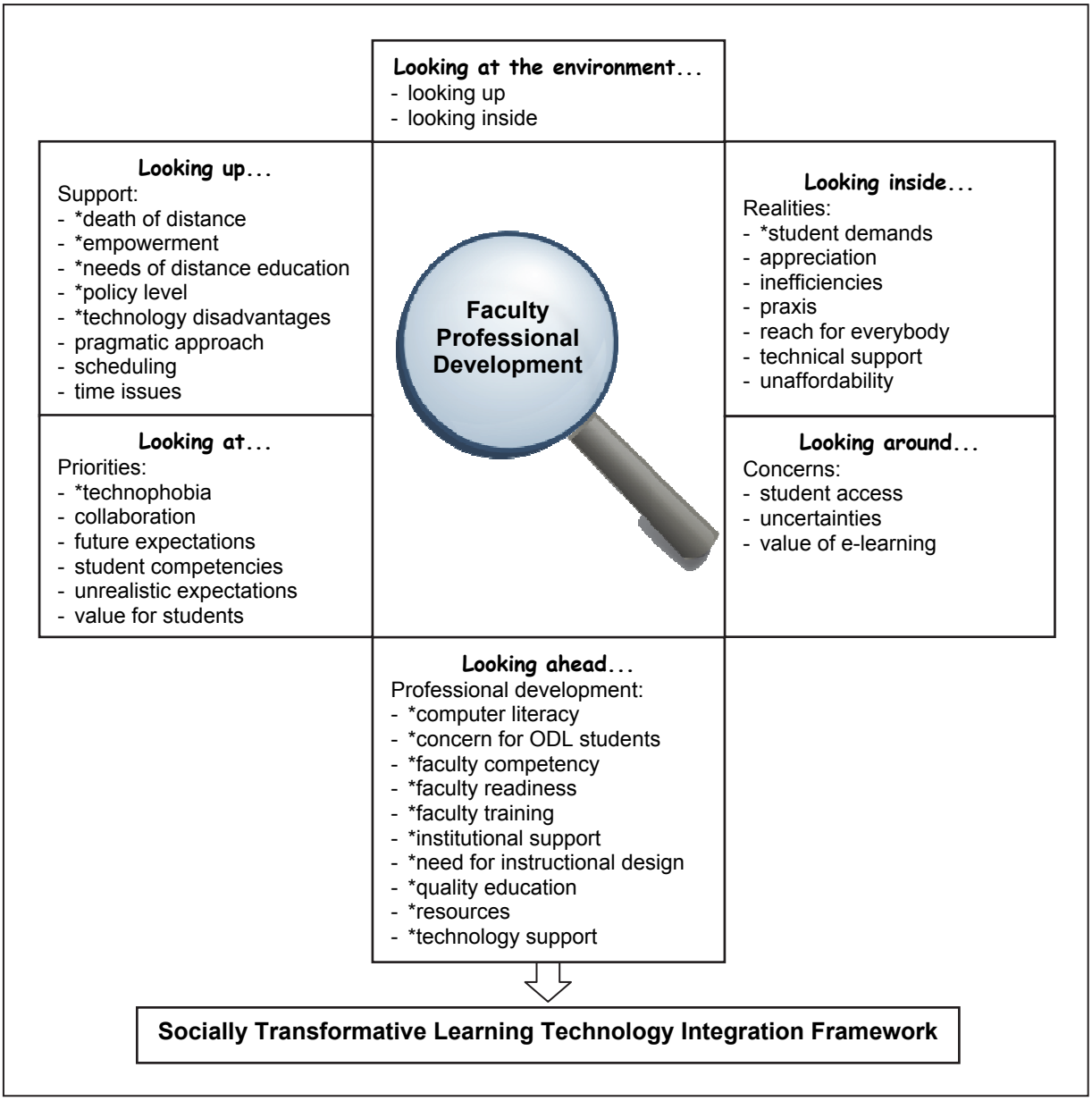
One of the previous DBR cycles involving the initial learning technology framework development identified prominent aspects as part of a learning technology framework. The first group identified as one of the prominent aspects is the teacher-students, studying to improve their qualifications. Following a learner-centred approach, analysis of the requirements, vision, fears and challenges as articulated by the SCTE students contributed to the approaches of initial interventions introduced during lecturer professional development training. The lecturers as the second prominent aspect identified in the initial framework participated in repeated cycles of hands-on training in line with the possible interventions set forth in the initial framework. Attempting to address requirements of lecturers, cyclic DBR approaches included training of lecturers with students' requirements in mind; first steps in acquisition of appropriate infrastructure, presentation of ODL requirements to the institution and IT support services and on-going evaluation of progress. A tailor-made questionnaire administered during lecturer hands-on training contributed to analysis of perceptions of the environment in which SCTE lecturers have to address the realities of adopting TEL.

The study followed a fully mixed sequential equal status design of mixing sequential qualitative and quantitative findings. Data collection strategies through a custom-made questionnaire, interviews with faculty members and longitudinal observations by the e-

learning manager produced 34 qualitative codes during the first phase of analysis. After quantitating the data, a t-test indicated significant differences between seventeen variables. The model emerging from the analysis concerns perceptions of lecturer (faculty) professional development in terms of (i) the environment in which faculty members adopt TEL from the perspective of support from the institution; (ii) the environment in which faculty members adopt TEL from the perspective of local realities; (iii) the human factors relating to the adoption of TEL; (iv) the concerns and reservations relating to the use of TEL; and (v) the continuous professional development requirements, expectations and motivators of faculty.

This analysis indicated the agreement and disagreement of the development variables between the perceptions of the faculty and the observations of the e-learning manager. While the faculty mainly zoomed in on TPACK issues (Mishra & Koehler, 2006), the e-learning manager zoomed out to strategic issues in order to gradually shift the teaching and learning approach from an instructivist towards a more constructivist approach (Jonassen *et al.*, 1995).

Perceptions of the environment as expressed by SCTE NWU lecturers: The five aspects of the model comprise the (i) environment in which faculty members should gain support from the institution, (ii) the environment in which faculty have to address the realities of adopting TEL; (iii) human factors relating to the adoption of TEL; (iv) concerns and reservations about the use of TEL; and (v) continuing professional development requirements, expectations and motivators (Figure 3).



(* significant difference p≤0.05) (Esterhuizen *et al.*, 2012a)

Figure 3: Model for Faculty Development towards Socially Transformative Learning Technology Integration for Open Distance Learning

3.1.5. Sub-Question (e)

> How should the prominent aspects in a framework for the integration of learning technologies in open distance learning at NWU be addressed?

The fifth research paper included in this study (Esterhuizen & Blignaut, 2012) classifies the prominent aspects identified through the preceding DBR cycles into three groups: *Perspectives, Environments* and *Objectives*. It proposes that *People-Technology Interaction in Teaching and Learning* is characterised by complex inter-relationships between aspects.

This is true for aspects within each group as well as between aspects in each of the other groups.

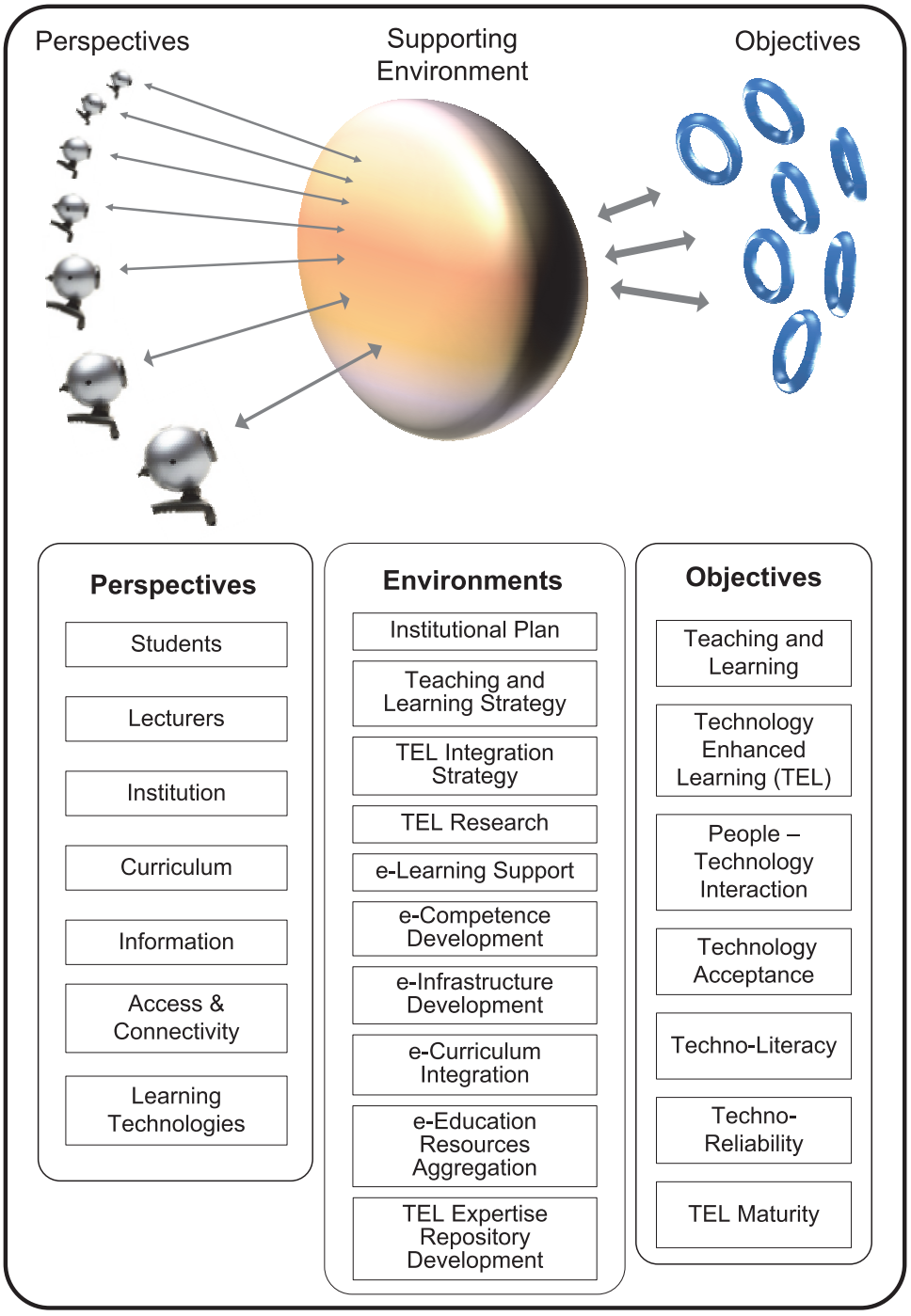


Figure 4: Interaction between aspects grouped as Perspectives, Environments and Objectives (Esterhuizen & Blignaut, 2012)

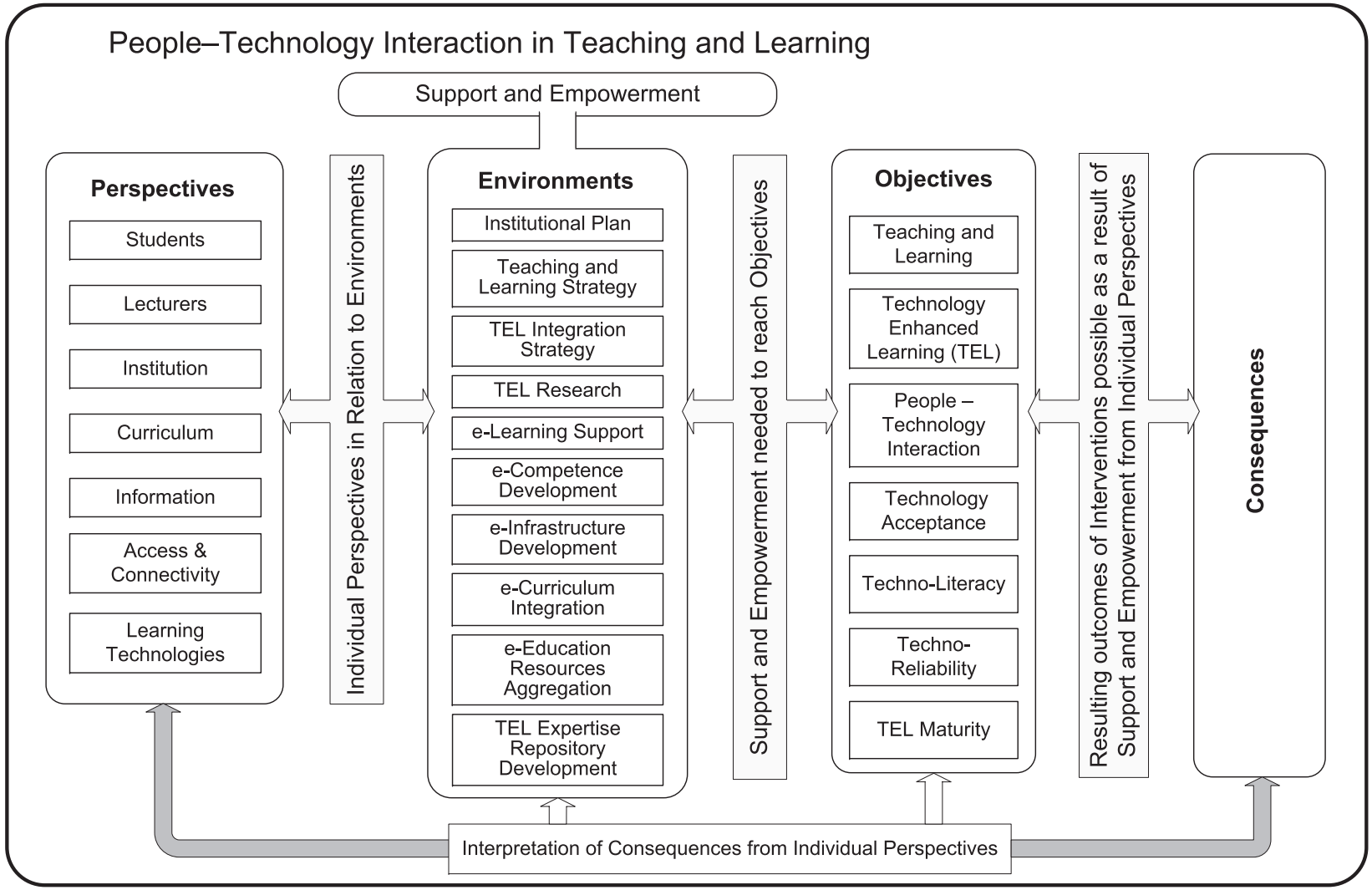


Figure 5: Relationships between Perspectives, Environments, Objectives, Consequences with Support and Empowerment needed

For any proposed TEL initiative, it is possible to approach the process from an aspect in any of the three groups. Mismatches between affordances and requirements towards reaching *Objectives* within relevant *Environments* would need pre-emptive support to reach intended consequences (Figure 5). Interventions required for social transformative TEL integration are classified into top-down and bottom-up interventions. Top-down interventions are seen as reactive measures resulting from mismatches between intended consequences and achieved consequences when TEL integration is effected towards *Objectives* from *Perspectives* of each of the aspects in the first group. The implication is that such unsettling interventions are error-driven and happen after the occurrence of a mismatch. Pre-emptive unobtrusive *Seamless Support* is advocated, based on latent requirements of participants and engineered through bottom-up inspired forward-looking provision in anticipation of requirements. The e-learning manager aims to provide effortless teaching and learning experiences for both students and lecturers where obstacles will only be encountered if they serve a definite purpose in the intended learning process. He advocates using initial DBR cycles as part of short term objectives to inform a general approach of *Seamless Support*, pre-empting requirements determined by a forward-looking bottom-up process listening to unuttered requests of participants.

4. Concatenation of the Sub-questions to address the main Research Question

Using an adapted DBR process, five distinct DBR cycles collectively address the Research Problem to address the Main Research Question through one overall macro DBR cycle. Each of the DBR cycles addressed one of the five Sub-Questions and each resulted in one of five research papers collectively comprising this PhD study.

4.1. Findings, Recommendations and Opinions

As participant observer from the position of *methodological pragmatism* as a method of inquiry, the researcher summarises the main points in findings, recommendations and his own opinions of the research papers included as part of this study.

4.1.1. SCTE Students comprising Teachers upgrading their Qualifications

Within the sample of 338 teacher-students attending additional contact sessions after their unsuccessful completion of a computer literacy course:

(i) Extensive barriers exist for population-wide ICT adoption

(ii) Perceptions of technological disadvantage are prominent

(iii) Access to computers and the Internet is insufficient

(iv) Expressed technophobia is small, but need of assistance is significant

(v) Qualitative analysis reveals significant technophobia

(vi) While qualitative analysis yields perceptions of 55% considering themselves competent in using computers, this could be misleading since after basic introduction to using computers menial activities such as switching on a computer and using a mouse to navigate represent computer literacy to some

(vii) An overwhelming majority declared that they look forward to using computers better, while 94% consider computers useful for everyday life and 78.5% believe their learners may gain from using computers

(viii) Strong intentions of perseverance in attaining functional computer literacy are evident, with 95.1% thinking computers will make their work easier if they are better skilled

(ix) In relation to TAM (Davis *et al.*, 1989), the students in this sample already have *Behavioural Intention to Use* computers right from the start. The intention to persevere towards attainment of functional computer literacy was shown through the perception that computers will make work easier and that school learners will benefit from using computers. Interventions should therefore not attempt to focus on cultivating the *Intention to Use* with participants; the question should rather be what interventions will be needed to adopt technology use amidst an established intention, but an apparent failure to attempt and persevere towards competence

(x) Support and enablement are required to promote trust to attempt using computers, necessary to obtain self-confidence through accomplishment. In this way perseverance to attain functional computer literacy may be cultivated

(xi) Recommended interventions include focusing on initial assessment of computer literacy, followed by tailor-made ICT training at contact centres, introduction to learner management system use, library use, information gathering techniques, study methods, as well as reading and academic writing competencies

(xii) Once acceptable computer literacy has been established, technological acceptance should enable some online and other interactive media alternatives such as mobile learning

(xiii) Progressive integration of technology into teaching and learning could develop together with e-readiness of the older generation of teacher-students.

4.1.2. SCTE Lecturers

(i) Lecturers, the enablers of adoption, emerged as a powerful positive group dynamic and pride, while consciousness of student needs established momentum in dedication through a strong work ethic

(ii) Lecturers are committed to development, further qualifications, and research

(iii) They are convinced of the need of technology adoption and perceive learning technologies as the way forward. They have expectations of technology mastery and are willing to learn through experience

(iv) Lecturers require bold decisions from the university as institution to foster creativity and enable learning content and curriculum transformation

(v) Lecturer barriers link to excessive workload, insufficient time and unfamiliarity with the affordances of new technologies

(vi) Lecturers strongly request training as first hand experiences

(vii) Lecturers have to perform extreme paper-based assessment duties, as well as develop skills in using the new learning technologies

(viii) Some lecturers perceive their computer literacy levels to be inadequate

(ix) In some cases, technological disadvantage and technophobia hinder learning technology adoption and lecturers are hesitant to experiment with the new technologies by themselves

(x) Prominent themes include critically insufficient time due to extensive workloads, and the need for comprehensive practice-based training

(xi) Additional academic staff should receive real-time support from in-house instructional designers, graphic designers, media designers and information technology assistance

(xii) Lecturers should have opportunities to experiment with e-learning techniques and develop skills, acquiring first-hand experience, all of which should be informed by research

(xiii) Innovation and creativity: Cultivation of an innovative environment given the staff-to-student ratios while maintaining the powerful positive group dynamic and pride may need a generous mix of resources. One of the most valuable resources leaders may allocate in order to foster creativity is time. Williams (2001) maintains that productivity goals seem to undermine creativity. In addition, access to funds, materials, facilities, and information support creativity (Amabile *et al.*, 1996).

Lecturer training was part of the urgent interventions needed in the beginning of 2011 which necessitated performing research and design simultaneously. The following extract from the fifth research paper included in this study illustrates the process:

> The training they required had to focus on instilling confidence while cultivating unconscious competence in using technology (Jung, 1990). At the same time, some lecturers perceived themselves as in need of improved computer literacy. The complex nature of teaching and learning using electronic technology is aptly illustrated during the entire process of training interspersed with practical application. Observation of lecturers using IWBs enabled the development of training opportunities, and the collaboration process produced refinement of solutions in practice regarding human factors and technology affordances. Discussions, observations, as well as structured and open-ended questions in training evaluation surveys contributed to evolving strategies for training and support. Within the space of a few months lecturers were confidently interacting with students across Southern Africa in synchronous computer mediated IWB conferencing. High levels of technological reliability and relative ease of use had been established (Esterhuizen & Blignaut, 2012).

4.1.3. The University as Institution

(i) Cognisance of the need for TEL integration is evident in institutional initiatives to mobilise dialogue around learning technology use through technology task groups. Discussions are progressing towards developing an e-Learning Strategy alongside the university Teaching and Learning Strategy

(ii) The university has an established learner management system (LMS) based on Sakai (http://www.sakaiproject.org) called eFundi. It is extensively used by NWU

on-campus (contact) students. As a result of technological disadvantage and digital illiteracy SCTE ODL students are not utilising the LMS. Challenges in terms of adoption of LMS use by large numbers of SCTE students include expansion required in terms of staff and facilities

(iii) Several university pilot projects involving learning technologies for on-campus students are under way. Aims of this present study include setting the stage for piloting learning technology projects involving SCTE ODL students

(iv) Institutional Information Technology Central (ITC) service department is taking part in discussions with SCTE around needs for TEL expansion required for ODL

(v) During 2012, SCTE buildings on campus have been furnished with Wi-Fi coverage

(vi) At the request of the SCTE e-learning manager, a pilot project was initiated by NWU ITC to provide SCTE with affordable lecture capturing facilities. This resulted in provision of a successful lecture capturing service based on Galicaster (www.galicaster.org) and Opencast Matterhorn (http://opencast.org/matterhorn/). SCTE is encouraged by commitment and dedication of NWU ITC in supporting technology requirements

(vii) Provision of access and affordability of Internet connectivity to thousands of SCTE ODL students across Southern Africa remains a challenge. Ideally, Wi-Fi connectivity at the 39 regional support centres would enable introductory online learning initiatives. The present ADSL line subscriptions to these centres arranged by SCTE would not be able to supply large scale affordable connectivity. Many SCTE students have to travel great distances to reach regional support centres. Ubiquitous Internet access is needed at schools and where SCTE students live

(viii) Generous resources are available throughout the university to enable research into TEL integration. University research support is extensive.

4.1.4. The Curriculum

(i) The institution has an established history of quality assurance of the existing curriculum benchmarked against international standards. On-going research

informs the curriculum and in-house programme evaluators assess existing courses (Kok *et al.*, 2008)

(ii) However, ODL delivery does not yet comply with the South African Government's policy on e-Education (2004)

(iii) Comprehensive instructional design relating to curriculum, pedagogy, and choice of an appropriate multi-media mix should focus on optimally engaging learners while learning with technology. There is need of evidence-based and collaborative decision making

(iv) ICT literacy should be integrated into the curriculum and not treated as free-standing instruction

(v) Information literacy, searching and classification competence should be promoted throughout the curriculum

(vi) Interventions should focus on learning strategies instead of technologies *per se*. Bold initiatives are needed to invest in capacity building with instructional design and technology based course curriculum renewal informed by localized research

(vii) Creativity is needed to transform from a paper-based distance learning curriculum into a higher order teaching learning experience made possible through the use of learning technologies.

4.1.5. Information

(i) It is possible to access electronic information sources off-campus through the institution's library website hosting a large collection of electronic databases, free research publications and e-books

(ii) Search procedures are uncomplicated and specialist training sessions are available. However, ODL students' inadequate computer literacy and connectivity issues limit access to the library online facilities

(iii) SCTE students' unfamiliarity with the library services expands the virtual distance to library support services and students require timeous training in information collection

(iv) Lecturer training must include initiatives to foster collaboration between students as well as between lecturers and students for the sharing of information

(v) Interactivity must be promoted around IWB sessions. Students should be guided in exchanging information and ask questions before, during and after IWB sessions

(vi) The use of Social Network Systems (SNS) must be promoted to foster collaboration and build communities of inquiry among SCTE students and lecturers.

4.1.6. Access and Connectivity

(i) Country-wide mobile connectivity and affordable broadband availability has improved

(ii) Of the SCTE students attending additional contact sessions after their unsuccessful completion of a computer literacy course, only 23.3% respondents strongly agreed that they have easy access to a computer and only 9.2% indicated easy access to a reliable Internet connection. When combining *strongly agree* and *agree* responses, about 60% of the teacher-students indicated access to a computer, while less than a third of the respondents (29.1%) indicated access to a reliable Internet connection

(iii) Campus internet connectivity is far in excess of the national norm and Wi-Fi is available on campus. However, up to hundred-fold variations in Internet speed may be experienced at times on campus

(iv) Conflict exists between the institution's Internet security policies and free access. ODL students visiting SCTE need to be connected through non-university Internet access, due to elaborate processes required to register on the university network

(v) SCTE had to acquire its own ADSL connectivity at regional support centres, install its own interactive whiteboards and SCTE ODL students pay for their own access and connectivity

(vi) Perceived information technology management barriers such as access, security, infrastructure and on-demand support should be addressed to the satisfaction of all concerned.

4.1.7. Learning Technologies

Steps toward successful adoption of learning technologies include:

(i) SCTE teacher-students are positive about technology use

(ii) SCTE lecturers have successfully adopted IWB use for computer-mediated communication

(iii) In general, SCTE lecturers see only learning technologies prominent at present when prompted for their opinions on utilising more learning technologies. Since IWBs have been dominant in the training and use of SCTE lecturers since 2011, they dominate in their thinking around learning technologies. Only DVDs and SMS technology appear as distant alternatives in the minds of SCTE lecturers in terms of learning technology use

(iv) e-Mail is hardly used yet and LMS use is not prominent, since its use is restricted to storage of course content, study guides and previous examination papers

(v) Mobile devices are proliferating; new generation teacher-students are familiar with mobile devices; use of social networking is becoming widespread

On the other hand, limited computer literacy, technological disadvantage and technophobia of students and staff hamper SCTE's employment of the few learning technologies already in use.

4.2. Differentiating between General and Significant Requirements

During exploratory analysis of perceptions of SCTE students on computer literacy, the numerous requirements in the present context that have to be addressed appear overwhelming. The researcher prioritised some perceived requirements in order to suggest possible priority interventions. Among the themes emerging from the computer literacy survey, he classified certain requirements as *General Requirements* and others as *Significant Requirements*.

The researcher considered themes such as perceptions of being *Historically Disadvantaged*, *Current Access to Computers to Blame, Access Expensive, Restrictive Current Education System* and *Expressed Desire to Use Computers* as *General Requirements,* which require *Access to Computers* and *Access to Connectivity.* Themes such as perceptions of

Acknowledged Computer Incompetence, Desired Computer Competence and *Anticipated Support* he considered as *Significant Requirements*, which require *Access to Support*.

General Requirements need expensive interventions such as provision of thousands of SCTE students with computers or tablet devices. It also involves supplying connectivity to SCTE students where they live and work, or even at a lower, but still significant level of expenditure to provide connectivity to students at the SCTE regional support centres.

In terms of resources, *Significant Requirements* need extensive planning and curriculum development. Possible interventions to address *Significant Requirements* could be pre-assessment and profiling of SCTE students with the intention to provide *Personalised Development*. *Personalised Development* should also include introduction to learner management system use, library use, information gathering techniques, study methods, as well as reading and academic writing competencies. Apart from initial introductory learning units, elements of these development themes should also be integrated with the curriculum over the whole duration of study in increasing complexity and progressing to more ill-structured problems.

Secondary to pre-assessment and profiling of SCTE students would be to provide those in need of basic computer literacy training hands-on one-on-one ICT training at regional support centres. This is an expensive intervention which again resorts under *General Requirements*.

There is association between internal, external and time dependent preconditions and the interventions to address *General Requirements* and *Significant Requirements.* Due to the expensive nature of interventions required under *General Requirements,* preconditions to these interventions would be external. Some interventions required under *Significant Requirements* could have only internal preconditions (§ 3.1.1Examples of external preconditionsExamples of external preconditions). The possibility of SCTE addressing some of these requirements without dependence on initiating involved institutional motivation processes prompted the researcher to consider differentiation of these requirements in the first place.

4.3. Differentiating between Reactive Interventions and Seamless Support

Argyris (1976) considers organisational learning to include a process of detection and correction of errors. Error-driven provision of support cannot provide optimal learning experiences. In closed-loop control systems, a sample of the output is compared to a

reference. Errors resulting from differences between the feedback sample and the reference are reduced through corrective actions of the control system using negative feedback. Reactionary support towards TEL integration would be characterised by attempts to rectify errors in actual outcomes compared to intended outcomes, which implies that mistakes are inevitable to attain some measure of stability. In order to reduce the impact of errors, reaction time must be minimal. The result could be rapid-reaction erratic interventions, experienced as uncertainty and instability in learning processes. When reaction time is slow, the effects of unintended errors are aggravated. Ideally, provision of support towards pleasurable learning experiences should be informed by latent requests of participants. The unuttered requirements should guide pre-emptive support provision. In addition to feedback, feed forward algorithms are needed in design processes to provide stable control of learning experiences. Seamless support should sustain learning enhanced through technology, based on bottom-up driven requirements built into timeous planning of empowerment and provision. This progressive approach to provision of support in response to requirements has elements of the double-loop learning principle and Deutero-loop learning where the learning process itself is examined and improved upon (Argyris & Schön, 1978; Bateson, 1979). Seamless pre-emptive support through a strategy containing forward-looking top-down interventions as well as bottom-up initiatives listening to latent requirements must provide an effortless travelling experience to participants crossing the digital divide.

Simply put: If actual **Consequences** as a result of initiatives to implement TEL within given **Environments** differ from intended **Objectives,** differences represent errors. Using negative feedback, corrective actions should initiate interventions. Before stability can be reached and the differences between intended **Objectives** and actual **Consequences** disappear, corrective actions (interventions) are needed. In TEL integration, the ideal would be to predict what support and empowerment would be needed to reach desired consequences and provide the support and empowerment in advance. **Environments** should match perfectly with the requirements from each of the **Perspectives** without the need of interventions as a result of detected mismatches.

4.4. A General Approach to People-Technology Interaction in Teaching and Learning

The *Initial Framework* focussed on seven aspects and suggested interventions to transform each of these from an ascribed social status before transformation to a transformed status (Esterhuizen & Blignaut, 2011). This *Initial Framework* is temporal, since as soon as aspects have been transformed by administering interventions emerging from requirements at the

time of performing the specific DBR cycle, the prescriptions and recommendations of the framework become obsolete. For this reason the researcher used prevalent aspects emerging in papers two, three and four in this study and during the related DBR cycles to contribute to the development of a *General Approach* included in the emergent TEL framework presented as paper five in this study (Esterhuizen & Blignaut, 2012). This *General Approach* may be used in the medium and long term. To establish a *General Approach* it was necessary to identify relationships between prominent aspects and the principles involved when they interact during attempts to integrate TEL at the SCTE. The aim was to look beyond specific interventions needed for transformation of specific aspects to enable reaching objectives in given environments and establish a *General Approach* which could be applicable to integrating TEL.

As TEL maturity develops in the medium and long term, prominent aspects may be replaced by others with higher prominence as priorities change. The *General Approach* emerging as a result of the overall macro design cycle of the adapted DBR approach used in this study may be applicable, since the process of selecting perspectives and objectives operating in applicable environments may be useful in future macro DBR cycles. Principles of DBR research approaches in educational technology research (Herrington *et al.*, 2007; Reeves, 2006) include:

- Analysis of practical problems in close collaboration with practitioners
- Developing solutions, iterative cycles of testing and refinement of solutions in practice
- Reflection to produce design principles and enhance solution implementation
- Refinement of problems, solutions, methods, and design principles.

These steps of DBR approaches in educational technology research could be applied to inform relationships using the *General Approach to People-Technology Interaction in Teaching and Learning*. Figure 6 illustrates the process.

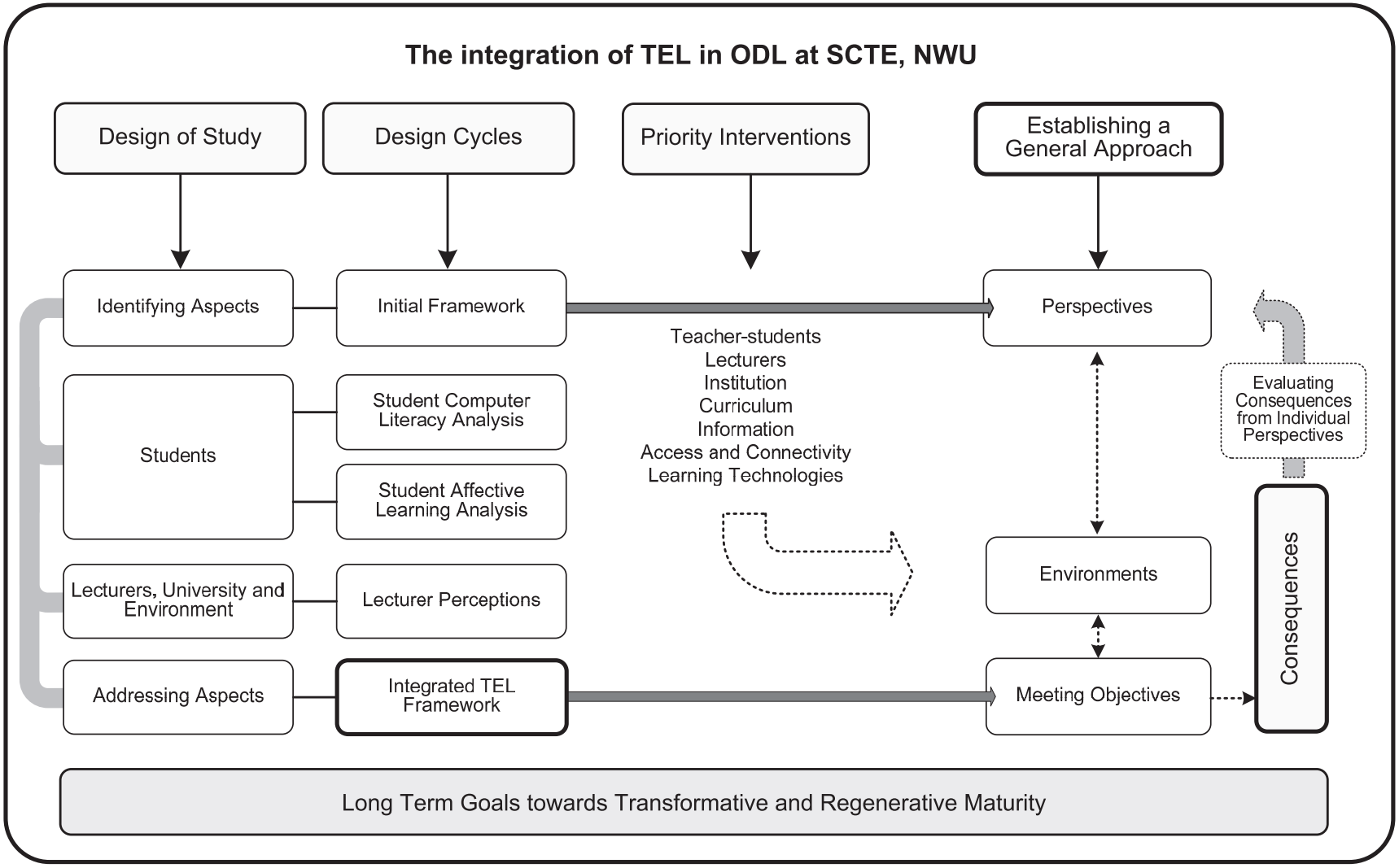


Figure 6: Overview of the design process in developing a General Approach towards a framework for integration of TEL at SCTE, NWU

The overview of the design process in developing a *General Approach* towards a framework for integration of TEL at SCTE, NWU (Figure 6) firstly shows the *Design of Study*; based on addressing the five Sub-Questions to the Main Research Question. *Design Cycles* show the five adapted DBR cycles, each addressing one of the Sub-Questions and *Priority Interventions*; the interventions recommended in the *Initial Framework* which could be performed immediately and the dependency on the *Environments* at the time. Through the DBR research approaches in educational technology research as applied in the current setting, the fifth research paper presented a classification of prominent aspects into three groups. The seven aspects included as prominent in the *Initial Framework* were seen as *Perspectives* in the *General Approach.* With the aim to address identified prominent aspects in a socially transformative people-centred learning technology integration framework, research papers two, three and four each represented perspectives from each of the aspects. Paper two looked at computer literacy and paper three looked at emotional reactions to computer literacy training from the perspective of SCTE students. Paper four was about perspectives of SCTE lecturers contrasted with the perspective of the e-learning manager in relation to professional development using learning technologies. Classifying aspects such as the *Curriculum, Information, Access and Connectivity* and *Learning Technologies* as having their own *Perspectives* may be confusing to some. However, in terms of interacting with *Environments* to reach *Objectives*, consider the following example:

If the *Objective* is to achieve optimum *People-Technology Interaction*, the *Institutional Plan* should sanction in principle the promotion of *People-Technology Interaction* (Figure 5). Having established that, the relevant university office should allocate resources and execute responsibility primarily through the *Teaching and Learning Strategy* and secondarily through the *TEL Integration Strategy* into achieving the required *Objective*. To reach the *Objective* of optimum *People-Technology Interaction*, *TEL Research* should inform requirements and prescribe required *e-Learning Support*. In this way, other *Environments* may be involved as well.

From the *Perspective* of *Learning Technologies* looking at *Environments*, it is conceivable that certain *Learning Technologies* could be better suited to reach the *Objective* of optimum *People-Technology Interaction* as a result of being better supported through certain *Environments*.

For instance: Attempting to utilise Mobile Learning to optimise *People-Technology Interaction* in Teaching and Learning. From the *Perspective* of Android smart phones, the first four *Environments* shown in the group do not pose difficulties in achieving *People-*

Technology Interaction. However, from the *Perspective* of Android smart phones, *e-Learning Support, e-Competence Development, e-Infrastructure Development, e-Curriculum Integration, e-Education Resources Aggregation* and *TEL Expertise Repository Development* cannot be seen as supporting Mobile Learning from the *Perspective* of Android Phones without additional *Support and Empowerment.* Possible mismatches could be:

(i) The existing Curriculum does not appear friendly to *People-Technology Interaction* with mobile learning from the *Perspective* of Android smart phones. The curriculum needs adjustment, not in terms of outcomes, but in terms of how these outcomes may be reached utilising Android smart phones. In this way, from the *Perspective* of the particular *Learning Technologies*, within the *Environment* of *e-Curriculum Integration,* additional *Support and Empowerment* will be needed to achieve optimum *People-Technology Interaction*.

(ii) *e-Learning Support* will be required to design activities to reach Curriculum Outcomes using Android smart phones. Academic staff will need additional training and assistance through instructional design to re-focus their teaching and learning to achieve optimum *People-Technology Interaction* from the *Perspective* of Android smart phones.

(iii) *e-Education Resources Aggregation* will need educational resources with which the Curriculum outcomes may be reached from the *Perspective* of Android smart phones. Once these learning objects have been developed or acquired, implemented and tested, more aggregated e-education resources would be available to share and re-apply in similar contexts. This would contribute to the *TEL Expertise Repository Development*, to be available when such objects are required from the *Perspective* of Android smart phones.

(iv) Using Android smart phones in the teaching and learning environment to achieve optimum *People-Technology Interaction* may result in unintended *Consequences.* Evaluating these *Consequences* from each of the other *Perspectives* through the different *Environments* could contribute to developing new requirements for *Support and Empowerment* in applicable *Environments*, using DBR approaches. For example, *Perspectives* from *Students, Lecturers,* the *Institution,* the *Curriculum*, *Information*, *Access and Connectivity* all may inform revised requirements for *Support and Empowerment.*

(v) Successful implementation or failure would contribute to *TEL Research* and *e-Competence Development* from the *Perspective* of Android smart phones. *TEL Integration Strategy* could be informed through *TEL Research* findings of the process of integration of Android smart phones into teaching and learning.

Thus, from the *Perspective* of Android smart phones intended to be used as *Learning Technologies* utilised in context of the given *Environments* to obtain optimum *People-Technology Interaction*, intended *Consequences* may be reached if the required *Support and Empowerment* is available.

The successful application of Learning Technologies according to the aspects shown in Figure 5 could be:

- Sanctioning the *Institutional Plan*
- Supporting the *Teaching and Learning Strategy*
- Empowering the *TEL Integration Strategy*
- Recommending *TEL Research*
- Supporting *e-Learning Support*
- Contributing to *e-Competence Development*
- Enabling *e-Infrastructure Development*
- Endorsing *e-Curriculum Integration*
- Building *e-Education Resources Aggregation*
- Expanding *TEL Expertise Repository Development*

Establishing a *General Approach* which could be applicable in People-Technology Interaction in Teaching and Learning could be illustrated through Figure 7 for TEL integration when some of the aspects prominent in the current study context are no longer prominent.

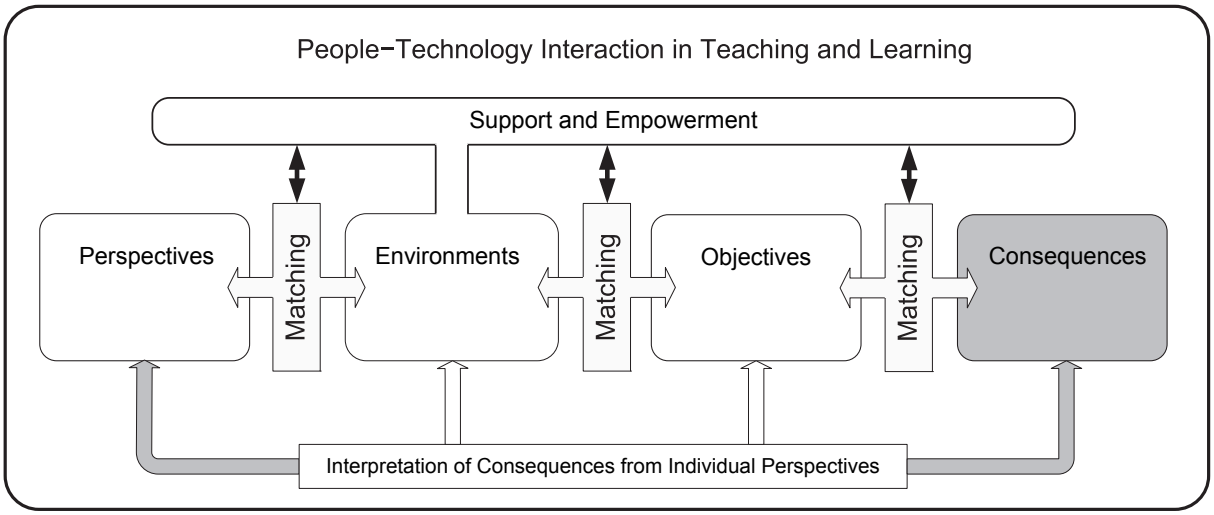


Figure 7: People-Technology Interaction in Teaching and Learning

As other aspects may be considered prominent in People-Technology Interaction in Teaching and Learning, they could be classified under *Perspectives, Environments* and *Objectives* to enable the determination of *Support and Empowerment* through *Environments* required for the purpose of matching aspects in order to reach *Consequences* in line with intended *Objectives*.

4.5. Classification of Maturity

Wenger (1998) used five types of relationship defining the acceptance that an institution might have in moving toward adopting the concept of a learning community: Unrecognized, Bootlegged, Legitimised, Strategic and Transformative. These inspired the suggestion of phases for classifying maturity in TEL integration at NWU for the purpose of this framework. The researcher suggests five phases ranging from Phase 0 (Unrecognised) to Phase 4 (Regenerative) for classification of TEL integration maturity. Every aspect from the three groups *Objectives, Environments* and *Perspectives* could be classified at a different maturity classification phase as stratified maturity.

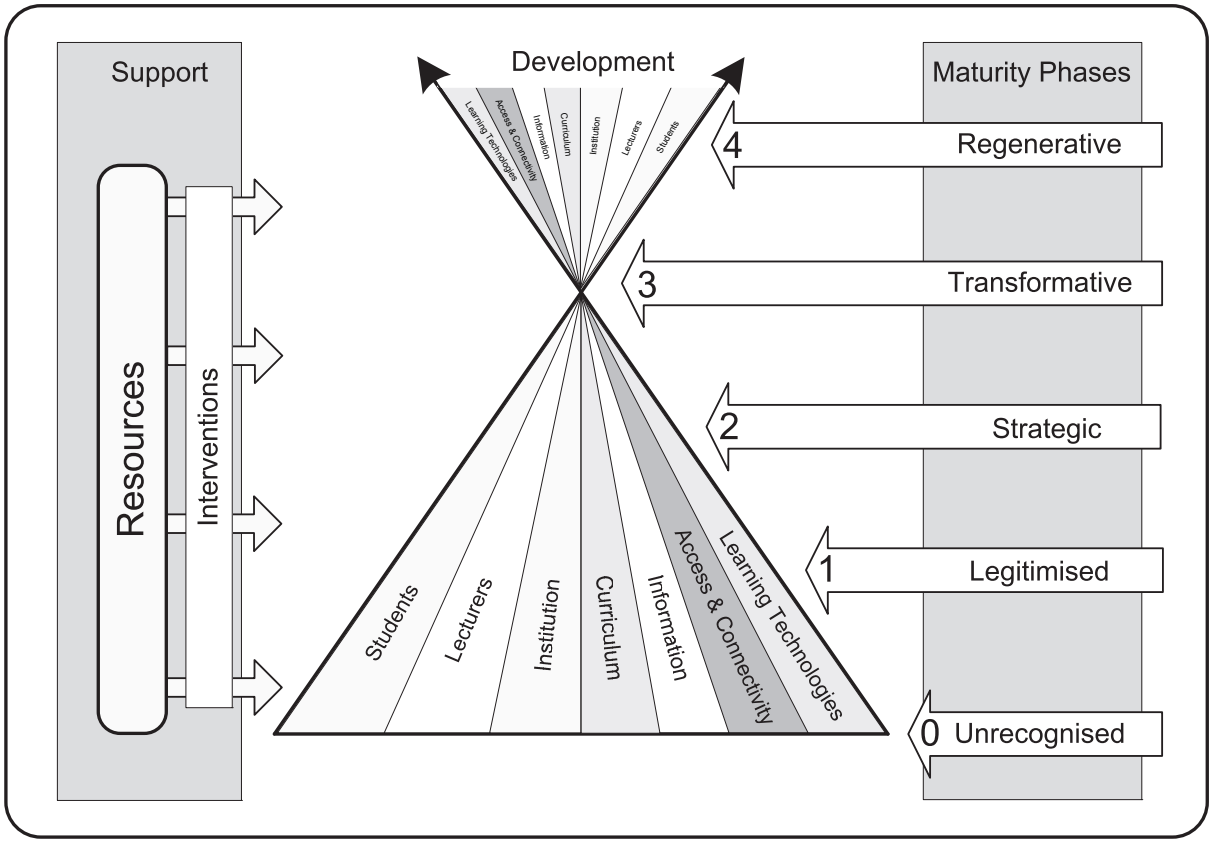


Figure 8: TEL integration maturity classification phases to evaluate evolvement in each of the aspects showing *Perspectives* in this instance

Maturity development increases vertically and the focal point in the diagram represents a point of transformation (at Phase 3: *Transformative*) where each aspect is transformed by acquiring new identity or meaning in relation to TEL in the local context. In Wenger's classification phases, transformation is described as a point where the concept is redefined: "Capable of redefining its environment and the direction of the organization" (Wenger, 1998). In this study, the researcher added a level beyond *Transformative* and designated it Phase 4: *Regenerative*. The intention is that when this level of maturity is reached, aspects acquire their own vitality and successfully reproduce their transformed identities or meanings into new contexts.

Since TEL integration maturity in many aspects in the current study is at level 0 (Unrecognised) or level 1 (Legitimised), this classification approach is decidedly theoretical and intended as a long term future orientated goal. The researcher's call for the university as institution to commit to a comprehensive TEL integration strategy displaying a declared intent with visible actions will mark Phase 1 in institutional TEL integration maturity classification. This strategy should evolve from the bottom up by inviting schools within faculties to collaborate and contribute to their own TEL strategies. At the same time, top-down

empowerment should demonstrate intent through visible commitment. Legitimised TEL strategies as a result of Phase 1 initiatives in relevant environments may over time contribute to visible curriculum maturity where technology is of strategic importance, integrated into core elements of the curriculum and not merely added on. Information TEL integration maturity classification in Phase 1 would be valid when students are required to demonstrate competency in information gathering, classification and utilisation.

Successfully concluding Phase 1 in institutional TEL integration maturity should result in Phase 1 lecturer TEL integration maturity once lecturers become aware of implemented TEL support initiatives. Enthusiasm to develop TEL activities in lecturers' subject areas is growing. Staff feel encouraged to spend time experimenting with learning objects introduced to students. Social communication tools become exciting to use. Benefits are discovered in utilising learning technology for students. Lecturers change from dictatorially managing content to being facilitators connecting learners in new ways to other learners, resources, and expertise: From being *the sage on the stage* to *the guide on the side*. On the part of lecturers, responsibilities for adoption should remain focused on teaching and learning, pedagogical requirements, and promoting cognitive presence, social presence and teaching presence in communities of inquiry. In a non-threatening environment using social networking the e-learning manager intends to instil self-confidence in lecturers as well as students, not by perpetuating anxiety but by exposure to technology and promoting accomplishment.

5. Priorities

The position paper included as the fifth research paper in this study states this in terms of priorities:

> From a top-down as well as a bottom-up approach, the university as institution should officially sanction technology enhanced learning (TEL) as a considered teaching and learning priority. On the one hand, bold initiatives are needed demonstrating evidence of responsible planning, commitment and empowerment on the part of the university as an institution. Through declarative visible interventions this top-down approach should demonstrate intent aimed at initiating action and gaining trust. On the other hand, unobtrusive pre-emptive support must be established in response to changing people-centred requirements through continuous feedback. This bottom-up approach should transform university environments as a result of listening to latent requests of involved stakeholders and provide pre-emptive sustained but evolving support towards People-Technology interaction. Productive and pleasurable educational transactions by students and lecturers will testify to the success of university initiatives towards successful integration of TEL. Empowerment initiatives in the form of comprehensive support should aim to enable effortless technology enhanced teaching and learning experiences (Esterhuizen & Blignaut, 2012).

5.1. Declared Intent regarding TEL from the University as Institution

TEL integration should be legitimised through visible commitment from the university as institution.

5.2. Focusing on People and Pedagogy instead of on Technology *per se*

In line with the Integrated TEL Framework:

- Consideration of *People* takes precedence over consideration for *Technology*
- All *Perspectives* must be considered, but first *Students*, then *Lecturers* and lastly *Learning Technologies*
- A dire need exists for comprehensive interventions around instructional design and curriculum and pedagogy design appropriate for online learning. Learning should be focused on optimally engaging learners while using technology.

5.3. Planning Pre-emptive Unobtrusive Seamless Support

The aim of the Integrated TEL Framework is to anticipate required support in order to prevent rapid-reaction erratic interventions. Mismatches between *Perspectives* and *Environments* should initiate forward-looking pre-emptive support based on bottom-up requirements. The latent requests of participants should be addressed before unintended consequences result by missing *Objectives.* To provide *Seamless Support*, early indications of latent requirements should be utilised and implemented as pre-emptive support to minimise inconvenience to participants

5.4. Academics as Enablers of Adoption

The e-learning manager will continue facilitation of on-going professional development of SCTE lecturers, focusing on interactivity. Hands-on training sessions using lecture capturing will be used within subject groups to discuss progress and aims objectively in a non-threatening environment. The group will discuss lecture capture recordings of each member of the group in turn, using closed recordings made during training sessions. By introducing informal use of social networking, social interaction could be cultivated through web-communication as a bridge to collaboration and interaction on academic level. Introduction of LMS use and facilitation will be introduced through a dedicated e-learning course for

lecturers. This course will use problem based learning to first build unpublished LMS sites for lecturers to experiment on, eventually publishing the sites as part of the subject modules lecturers are responsible for. Progress and focus of training will be people-centred, guided by the lecturers.

5.5. Introducing SCTE Students to Electronic Information

Interventions and pre-emptive support suggested regarding SCTE students should be prioritised. Together with e-learning champions from within the ranks of lecturers, students should be drawn into social network systems and LMS use, introduction to library use and information selection.

A bold initiative suggested by the e-learning manager would involve the development of online-learning facilitation using IWBs to introduce SCTE students and regional facilitators to online learning, first through synchronous interaction. Eventually, the modules developed on the LMS could be utilised asynchronously, creating full-fledged online learning use.

5.6. Online Learning at SCTE, NWU

TEL at SCTE NWU has barely started and virtually no asynchronous online learning takes place, especially as far as interactivity, collaboration and *anywhere, anytime, anyplace* are concerned. While SCTE still needs to take the first steps, new online learning initiatives proliferate in the rest of the world.

Masters (2011) considers Massive Open Online Courses (MOOCs) to be the fourth stage in an evolving process in online education.

Table 1: Four stages in Online Education (Masters, 2011)

Stage in online education	Characteristics
Stage 1: The lecturer places notes and presentations into an online repository or file server with a shared drive. The online environment is simply an electronic distribution area, with access through a network, often a Local Area Network (LAN)	Only students registered on the network have access to the course environment, and they download the material as required. Individual lecturers make their own choices about where and how to host their material. The lecturer is the *sage on the stage*. This approach was typically used in the 1980s and early 1990s
Stage 2: The lecturer uses a home-grown system or an externally-developed Learning Management System (LMS) or Virtual Learning Environment (VLE). In some instances, lecturers may use external web	Only students registered on the course have access to the course environment, usually available through Internet technology. The lecturer is still the *sage on the stage,* but other voices are heard.

Stage in online education	Characteristics
sites, but almost all activity is centralised on the LMS. Within the LMS, the concentration of activity is still on the lecturers' notes and presentations, but other tools such as chat rooms, discussion forums and wikis are available. Some learner-learner and learner-instructor online interaction does occur through these tools, but is frequently of little consequence to the course. The quiz and grade book tool show potential	This approach is typical of the 1990s
Stage 3: The LMS remains the centralised teaching and learning environment, but important changes occur in the relative importance of the various tools within the LMS. Most notably, the content area is reduced in importance, and the other tools, especially the discussion forums and chat rooms, are now prominent. Learner-learner and learner-instructor online interaction is common, and important to the course. The quiz and grade book tool become important management tools. Some courses venture into the use of online (even portable) ePortfolios. Other tools, such as wikis and blogs are also of some importance, but the learning model still emphasises a process of content acquisition, learning and testing. The creators of the LMS adapt the LMS to contain more *Web 2.0* tools, but these tools are, by definition, *contained* within the LMS	Only registered students have access to the tools, although the possibility for establishing publicly-visible links to some material does exist. When the students have *completed* the course, they usually no longer have access to it. The lecturer is now the *guide on the side*. Masters considers most teachers currently involved in online education to be, or aspire to be, at Stage 3
Stage 4: The MOOC. In Stage 3, the importance of the content area within the LMS was reduced. In Stage 4, the MOOC is decentralised and networked, and the network begins to resemble the patterns of the semantic web envisioned in Web 3.0. In this network, the importance of the entire LMS is reduced to one node in the network; the LMS is used primarily for management tasks (such as registration and learners' profiles) and hosting of discussion forums. In the MOOC, course is built upon the learners' participation, and their construction of information. Because there is no set knowledge base, if the learners do not contribute, there will be nothing to learn. Although the course instructors will supply some stimulus material, almost all of the	Most of the student activity happens outside of the LMS, on other nodes of the network, such as in personal blogs, personal portfolios, websites, tweets, uploads into video hosting sites (e.g. YouTube), networking sites and virtual worlds. Students then pass their information, frequently through automatic systems using Tags or RSS feeds, into a system (called an aggregator or curator) that aggregates the information with other information, such as that from the LMS's discussion forums. Learners will be independent, and frequently out of sight. Because the learners will be spread around the globe, many will access the online sessions as recorded sessions. It is unlikely

Stage in online education	Characteristics
content is supplied by the learners themselves.	that the instructors will be able to read and interact with all of the learners' contributions. Because they will be observing, the most privileged position an instructor could have is an identified *snoop in the group*.

Though in MOOCs learners will be independent and frequently out of sight, Masters sees the role of the instructor as crucial for success. "In all of this, the 'staying present' is crucial – the instructor should not move from the 'guide on the side' to the 'absentee landlord.' In practice, however, instructors will find themselves playing dual roles of facilitator and student. They may be keeping track of events and discussions, but frequently for purposes of learning" (Masters, 2011). Meeting goals and objectives in MOOCs may not be possible always or should not necessarily be intended:

> In a MOOC, assessment does not drive learning; learners' own goals drive learning. The learners set their own goals, based upon their own needs. They work towards those goals. Those goals may change as the course progresses. The course is a process of inquiry, and the level of inquiry is set by the individual learners. For example, if the learners wish to have only a superficial knowledge of the information available, that is their choice. There is no teaching to the 'test,' because there is no 'test.' The instructors may set 'tests,' and will set activities (akin to 'assignments') if they wish, but taking or 'passing' those is optional. Anybody, including learners, may set 'tests' and 'assignments,' and anybody (including instructors) may take them. The aim of participating in a MOOC may or may not be to obtain a credit, or a qualification – the aim is primarily to learn (Masters, 2011).

Masters sees the following related to MOOCs:

- While learners usually work independently when participating in a MOOC, some may form their own online groups and even meet face-to-face
- The instructors may run regular live online sessions (through tools like Elluminate and Wimba), but attendance by learners is optional
- The course has been integrated with something that carries all the power (positive and negative) of social networking, which could be scary for instructors as well as for students
- At first, the amount of self-regulation required by instructors and students will be daunting, but it may be more easily accommodated as progress is made. Education has never been for the faint-hearted!

- While the LMS is not yet dead, signs appear that its limits are becoming restraints on learning and that further adjustments may not meet demands of future learning. The appearance of MOOCs is one of the signs (Masters, 2011).

Promoting asynchronous online learning at SCTE NWU will need some drastic top-down interventions as well as seamless support in the form of pre-emptive unobtrusive actions.

6. Limitations of the Study

Limitations of this study relate *inter alia* to the sample used during *Student Computer Literacy Analysis* which may represent a single bounded case that is not generalizable to the population of teachers furthering there studies in South Africa. Future research should focus on objective e-competence measurement after support initiatives as recommended in the proposed learning technology integration framework have been implemented. Limitations also result through the use of selection sampling and reaching conclusions on observations of the researcher.

The methodology used was an abridged version of DBR, which has its limitations. Full DBR methods would have contributed more to the study. Empirical verifications are needed in each of the research approaches. From a position of *methodological pragmatism* as a method of inquiry, the limitation is that the researcher assumes licence to assert his own opinion. The findings and recommendations may not be generalizable.

7. Recommendations

The particular adaption of DBR strategy in this research involved five design research cycles collectively comprising only one macro DBR cycle. The purpose of this macro DBR cycle is to address an emergent TEL integration framework, as the conclusion of the current research. The recommendations of this one overall macro DBR cycle should initiate future macro DBR cycles in on-going TEL integration towards e-maturity at NWU. The five DBR cycles in the current research produced an initial technology integration framework, quantitative analysis of students' computer literacy, mixed-methods analysis of students' computer literacy learning emotions, mixed methods analysis of lecturers' perceptions during e-learning staff development and the emergent TEL integration framework.

In response to the main research question, the following general recommendations apply:

- Aspects prominent in a framework for the integration of TEL at NWU include seven areas in need of intervention according to the *Initial Framework* as presented in Paper 1. These seven areas were considered being *Perspectives* in the emerged framework as presented in Paper 5, in which numerous aspects were added under two additional categories labelled *Environment* and *Objectives*. Initiating interventions aimed at addressing the aspects under the *Initial Framework* is considered short term goals as recommendations based on this study. These include training of lecturers, innovative planning of time issues, acquisition of appropriate infrastructure, buy in from the institution and IT support services and orientation and initiation of teacher-students.

- A distinction between the *Initial Framework* (Paper 1) and the *Emerged Framework* (Paper 5 and this final section of the thesis) is that once the initial seven aspects had been successfully addressed through interventions, the *Initial Framework* will be rendered redundant. The aspects grouped into *Perspectives*, *Environment* and *Objectives* in the emerged framework are open to evolvement and is based on a *General Approach*, not a fixed recipe. Multiple relationships may be investigated and addressed in an evolving environment. Addressing some of the aspects in this framework may be considered medium term and long term goals.

- A *Classification of Maturity* is proposed with which TEL integration at NWU may be classified under five phases ranging from Phase 0 (Unrecognised) to Phase 4 (Regenerative). Attaining Phase 4 maturity in aspects prominent in integration of TEL would be considered long term goals. Objective e-competence measurement should be effected after initial support initiatives as recommended in the proposed learning technology integration framework presented in Paper 5 have been implemented.

Based on this study, the researcher provides the following recommendations as specific actions:

- TEL integration should be legitimised through visible commitment from the university as institution through declaration of intent, commitment to development, allocation of resources and adoption of a TEL Integration Strategy harmonised with an up-to-date Teaching and Learning Strategy in line with the Institutional Plan.

- The university as institution should commit to evolvement towards an e-mature organisation for the delivery of ODL.

- Interventions should heed lecturers' requests to manage their workload and scheduling of pedagogical priorities, interventions to overcome technological unfamiliarity, and TPACK training to use TEL effectively and ample provision of instructional design resources. Lecturers should receive real-time support from in-house instructional designers, graphic designers, media designers and information technology assistance. Bold initiatives are needed to invest in human capacity building.

- Lecturers should have opportunities to experiment with emerging technologies and social networking. Since lecturers may be required to participate in online activities after hours, their residential Internet connectivity should receive attention as well.

- SCTE should prepare comprehensively for appropriate TEL implementation, starting with the teacher-students who are in the position to utilise it.

- Internet bandwidth should be provided at regional support centres to facilitate teacher-students' Internet access while still maintaining sufficient bandwidth for continued synchronous computer mediated IWB conferencing.

- Students should be supported by empowering lecturers through proficiency in interacting with teacher-students on a technical level. Lecturer professional development should ensure that they attain much more techno-proficiency than is necessary for interacting around non-technical teacher-training subject content. Intensive participatory staff training should transform faculty to required maturity in these contexts.

- Curriculum maturity should be developed where technology is of strategic importance, integrated into core elements of the curriculum and not added on. Information TEL integration maturity classification in Phase 1 would be valid when students are required to demonstrate competency in information gathering, classification and utilisation, interaction and knowledge construction using technology. Students indicated a need for support and enablement to attempt to use technology and persevere towards competence.

- Participants in this research, as well as literature, agree that it is imperative to expand e-learning use at SCTE NWU as a result of the importance of TEL in ODL. Pre-emptive unobtrusive seamless support, based on requirements identified through

bottom-up feedback listening to latent requests of participants is recommended to enable TEL integration.

- Comprehensive interventions are needed around instructional design, educational resources repositories and appropriate curriculum and pedagogy to design for online learning. Learning should be focused on optimally engaging learners while using technology.

- Students require affordable mobile connectivity, adequate Internet access and computer literacy to enable substantial information exchange and collaboration.

- Provision of support towards pleasurable learning experiences should be informed by latent requests of participants. Seamless pre-emptive support through a strategy containing forward-looking top-down interventions as well as bottom-up initiatives listening to latent unuttered requirements should sustain learning enhanced through technology, based on timeous planning of empowerment and provision.

- Objective e-competence measurement should be effected after initial support initiatives as recommended in the proposed learning technology integration framework presented in Paper 5 have been implemented.

On-going research opportunities exist in every aspect of this study. Since the maturity levels in aspects included in the emerged integration framework ranges between *Unrecognised* and *Strategic*, but mostly not yet *Legitimised*; future research could focus on tracking progress and correcting inaccurate assumptions.

8. Contribution

This study intended to determine prominent aspects on the integration of TEL in ODL at SCTE, NWU, and how to address these in a socially transformative people-centred learning technology integration framework.

8.1. Contribution of the Study to TEL

Figure 9 shows a summary of contributions of this PhD study to research areas around TEL integration. The design of the study using DBR cycles collectively comprising one macro DBR cycle is an approach which could be useful in doctoral research.

8.1.1. Focus

The researcher initiated DBR short term cycles contributing to a focus on six research areas:

1) Socially transformative TEL integration

2) Perceptions on computer literacy

3) Perceptions on Technology Acceptance

4) Perceptions on Lecturer Professional Development from contrasting perspectives

5) Perceptions on Technology Support

6) Seamless Support-driven TEL integration framework.

8.1.2. Contributions

Contributions associated with these areas comprise:

1) People-Technology Interaction in Teaching and Learning

Figure 7 shows the essential components of the People-Technology Interaction in Teaching and Learning model: Aspects grouped in *Perspectives, Environments, Objectives* and *Consequences* where *Support and Empowerment* required through the *Environments* are determined by mismatches between these groups. Unintended *Consequences* as a result of aiming for *Objectives* from relevant *Perspectives* should be eliminated through unobtrusive pre-emptive *Seamless Support* (Esterhuizen & Blignaut, 2012).

2) SEM model: Requirements for Confidence to Persevere in Attaining Computer Literacy Competence.

Figure 1 shows a simplified version of the SEM model pertaining to attaining computer literacy competence of SCTE students who experienced difficulty in attaining computer literacy (Esterhuizen *et al.*, 2012b).

3) Two-dimensional Model for Computer Literacy Learning Emotions

Figure 2 presents a two-dimensional Model for Computer Literacy Learning Emotions showing relationships:

- Technophobia−Technophilia
- Incompetent−Competent.

4) SCTE NWU lecturers' perceptions of the environment

Figure **3** presents a Model for Faculty Development towards Socially Transformative Learning Technology Integration for Open Distance Learning. This explorative analysis according to a multimode research methodology resulted in a model indicating:

- Support from the institution
- Address the realities of adopting TEL
- Human factors relating to the adoption of TEL
- Concerns and reservations
- Continuing professional development requirements, expectations and motivators.

5) Relationships between aspects as Perspectives, Environments, Objectives, Consequences with Support and Empowerment needed

Figure 5 presents more detail relating to the current context of the study of Figure 7, which shows the essential components of the People-Technology Interaction in Teaching and Learning model (Esterhuizen & Blignaut, 2012). The aspects considered prominent in a framework for the integration of technology enhanced learning at SCTE, NWU in the current context are grouped into Perspectives, Environments, and Objectives.

8.1.3. Outcomes

From a position in this study of methodological pragmatism as a method of inquiry, the researcher's interpretation produced the following research outcomes. The researcher:

1) Discerns requirements regarding Computer Literacy as Significant or General Requirements

- Significant Requirements expect Extensive Planning and Curriculum Development

- General Requirements expect Expensive Interventions

2) Distinguishes between preconditions for interventions: Internal, External and Time-dependent

3) Distinguishes between reactionary interventions and pre-emptive unobtrusive Seamless Support

4) A *General Approach* towards medium and long term TEL integration based on *Perspectives* from key participants and TEL entities on *Objectives* of TEL. *Empowerment* through enabling *Environments* matches achieved *Consequences* to intended *Objectives*

5) Future TEL maturity classification phases to evaluate long term evolvement in each of the aspects

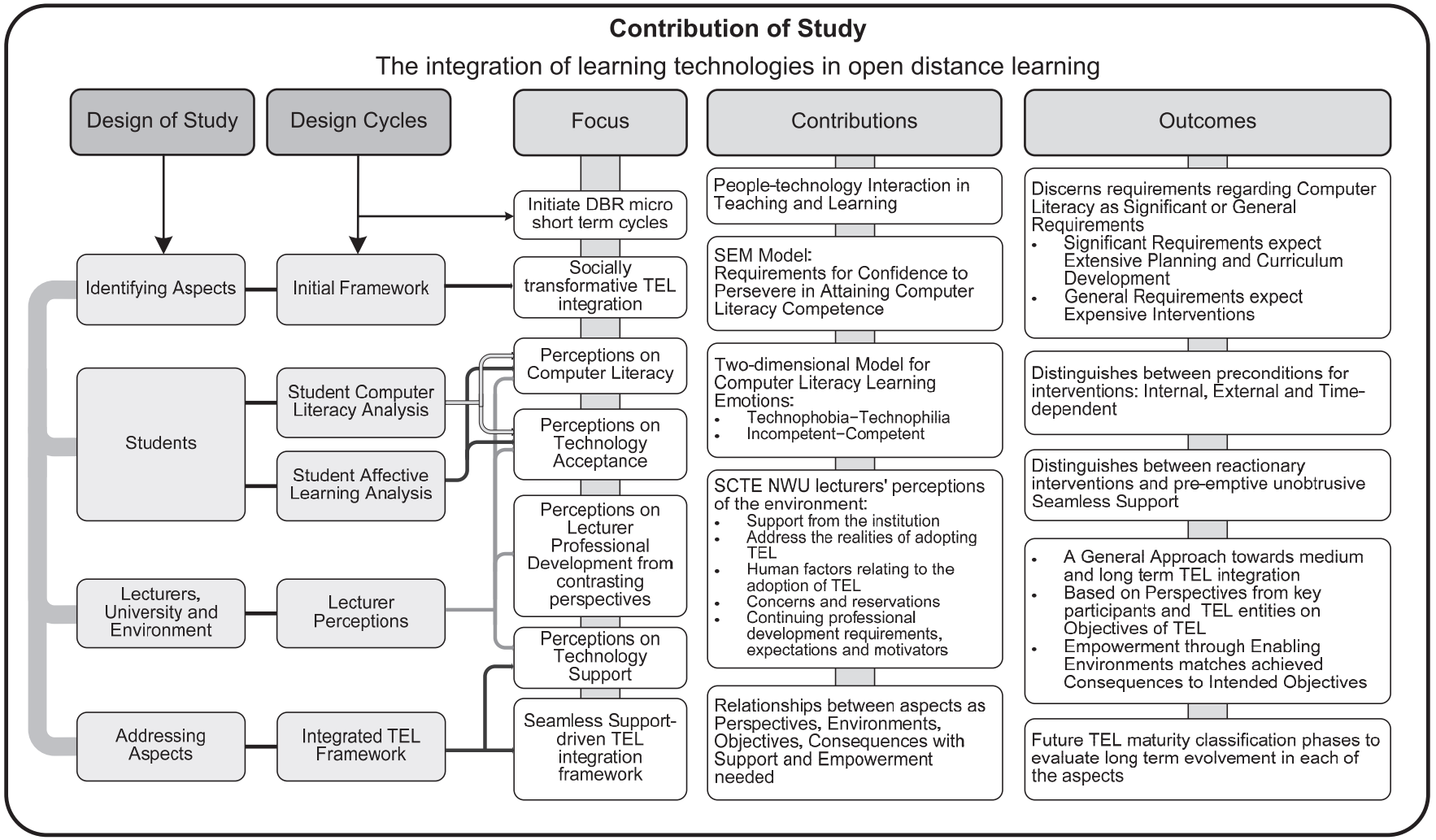


Figure 9: The Contribution of the Study

8.2. Contribution of the Study to TEL

1) Insight into SCTE students' perceptions of technology

2) Insight into SCTE lecturers' perceptions of technology

3) Identified aspects prominent in a framework for TEL integration

4) Identified interventions and support required for social transformation

5) Classification of prominent aspects into groups with inter-relationships

6) Intense need both on the part of SCTE students and lecturers for practical hands-on training

7) Supportive and enabling environments needed as preconditions for trust to attempt using computers to obtain confidence to persevere towards attainment of competence.

8.3. Perceptions of SCTE Students

Analysing perceptions of practising teachers busy improving their qualifications through ODL at SCTE, NWU, who have difficulty in passing computer literacy in Southern Africa contributes to research knowledge in the following ways:

(a) Significant numbers perceive themselves as technologically disadvantaged

(b) Very few are professing technophobia

(c) Qualitative analysis of perceptions reveal significant technophobia and technological incompetence

(d) They are decidedly intent on using computers. An overwhelming majority declared they look forward to use computers better

(e) Ninety four percent consider computers useful for everyday life

(f) Seventy eight point five percent believe their learners may gain from using computers

(g) Strong evidence of intentions of perseverance in attaining functional computer literacy, with 95% thinking computers will make their work easier if they were better skilled

(h) It informs the framework for the integration of TEL that SCTE should focus on support and an enabling environment to provide even these students the necessary confidence to attempt using computers and persevere to attain competence

(i) The cultivated self-confidence from participation in computer-mediated ODL could build perseverance to attain competence

(j) The implications for the learners at the schools where SCTE students teach are that teachers with attained computer literacy and confidence should contribute to the empowerment of their learners. For the learners, this may hold possibilities of collaboration with learners and teachers locally and across the globe, cultivated information literacy competencies, improved study methods and participation in the knowledge economy.

9. My Reflection on the Research Journey

As researcher my journey through this study has been especially rewarding. After working in industrial electronics at a nuclear research facility for five years, in broadcast engineering for ten and lecturing introductory Electronics for twenty years, I had first-hand experience of difficulties and accomplishment in building a comfortable relationship between people and technology. I accompanied students from disadvantaged backgrounds journeying to confidence in basic electronics use, who themselves were then able to assist other students in building circuits and interpreting responses. Many of these students would proceed to successful careers in telecommunication, industrial electronics or clinical engineering.

In 2001, I used hyperlinked HTML (HyperText Markup Language) pages to navigate through augmented learning material on a rudimentary interactive multimedia-CD (Compact Disc) to better explain basic electronics to students. I had the privilege of attending a full-time telematics education course in 2006. In 2008 I enrolled for this PhD study and was appointed e-Learning manager at SCTE in 2011. Each phase of the research journey has been a pleasant learning experience, progressively motivating me to contribute towards large scale utilisation of technology to enhance learning. I am convinced that living and learning with technology could establish confidence to innovate and create, utilise collective ingenuity and employ the knowledge economy to enrich people's lives. Through sharing unique

applications between learners and teachers, communicating experiences, cultivating lifelong learning habits and combining temporal novelties with timeless wisdom, the exploding abundance of information should be employed towards richness of life, not dumbfounded digital confusion. I wish to contribute towards mature educational practices providing demonstrated evidence of students, teachers and learners successfully learning and living, using technology.

While designing the computer literacy questionnaire used in the second and third research papers included in this study, I had to imagine what it would be like not being able to pass a module on computer literacy. Guided by literature regarding themes pertaining to possible scenarios of difficulty in attainment of technology competence to include in the questionnaire, I attempted at my own initiative to choose the sequence of questions in such a way as not to elicit feelings of being accused. Some questions were designed to provide opportunity to vent frustration. Questions were non-confrontational and positive in approach and questions which could be interpreted as reproachful were positioned later in the questionnaire. In the end, I was astonished at the depth of information emerging from the data. While quantitative data provided many useful insights, the open-ended questions really provided a wealth of information and the opportunity for me to appreciate aspects of the lived experiences of SCTE students struggling with computer literacy. I developed new appreciation through first-hand accounts of limited access to computers and connectivity, historical disadvantage, deep rural conditions and aspirations of improved conditions offered by technology, all of which were affirmed during interacting and interviews with SCTE lecturers.

Working in close collaboration with SCTE staff as e-learning manager has been a precious experience. I am humbled by dedication and concern of SCTE staff for thousands of practising teachers improving their qualifications through SCTE, NWU. Most of these teacher-students are busy with a full time occupation and have many individual responsibilities, pursuing further studies amidst considerable personal sacrifice. SCTE lecturers labour together in a delightfully inspiring group spirit, dedicated through a strong shared work ethic. They are committed to development, furthering their own qualifications and performing research, and are convinced of necessity and benefits of technology adoption. Expectations of technology mastery and a willingness to learn through experience manifest in the enthusiasm with which they approach new possibilities. While uncertain and hesitant towards technologies outside the presently familiar, new possibilities are not treated with defensive rejection but rather with open expectation. Honest about their perceived techno-limitations, they eagerly call for continued training and exposure. Even amidst

insufficient time due to excessive workload, unfamiliarity with new technologies, and in some cases perceived technological disadvantage and technophobia, these lecturers' willingness and applied effort serve as inspiration.

I enjoyed the many facets of complex interaction between technological affordances and people-centred processes which require alignment in practice. Implementing IWB technology and synchronous computer mediated conferencing; optimising People-Technology interaction and technology reliability and coordinating logistical requirements in a productive atmosphere have been gratifying as a result of an exceptional group of educational professionals with whom I could share my research journey. In practical application of research in close cooperation with participants through the adapted design-based approach, I have experienced the first major research cycle of many in which I eagerly anticipate transformation of each of the identified aspects in this study into teaching and learning maturity through technology. Many of the identified aspects in the SCTE have hardly progressed beyond being *Unrecognised* in terms of the application of learning through 21st century technologies. I consider the prominent *Learning Technologies* at SCTE using the Internet to interact with students at the regional support centres across Southern Africa through IWB computer mediated conferencing as approaching the *Strategic* phase of TEL integration maturity. This is only true in terms of preparing for imminent growth—as being a *Legitimised* first step in TEL integration for future survival, which is the only claim to being of *Strategic* importance. In real terms, for the many SCTE students who have not yet attended IWB sessions at regional support centres, this technology is not yet of *Strategic* importance. For them it is entirely *Unrecognised*. Searching for examples in the *Curriculum* where the affordances of TEL are essential to reach learning outcomes may reveal that general integration of technology in the broad *Curriculum* has not reached the maturity level of being *Legitimised*. Imagine if evaluating SCTE students in terms of their exit level information literacy would reveal a grasp of information retrieval, classification and application which enabled them to transform the science of information processing. Imagine if they attained international recognition that their revolutionary transformation of information processing has produced pockets of new application of information literacy practices outside the local context. If this were true, it would attest to reaching TEL integration maturity phase classified as *Regenerative*. To qualify for being classified at a lower maturity level of *Strategic* in this example, there should at least be evidence that reaching specified benchmarks of information literacy revealed as assessed information retrieval, classification and application skills are of *Strategic* importance at the SCTE. I look forward to a future where assessed

gains in the TEL integration maturity for a range of aspects in this framework could be mapped against progressing phases of maturity on a time line.

I delight in the prospects this research journey have produced and look forward to what further design cycles will reveal. Recognising possibilities in living and learning using technology to the extent that interaction between aspects included in the emergent TEL framework could provide should motivate provision of required *Seamless Support*.

During the research journey I have found some of the emerged findings to be particularly valuable. From literature, I developed the impression that building technology acceptance is usually a tedious process of overcoming reluctance and opposition on the part of potential technology users. It was a surprise to discover that even the SCTE students who experienced difficulty in passing the module on computer literacy were already convinced of their intention to use computers. These practising teachers considered computers useful and beneficial for themselves as well as for their learners. They also conceded that more of their own effort would be required to learn how to use computers better, but had no hesitation in volunteering to put in more effort. Many committed themselves while answering the questionnaire to buy their own computers, after declaring that computers were not available at the schools where they teach. In some responses, it appeared that utilitarian as well as hedonic motivations contributed strongly to intentions of gaining computer literacy. Being able to use computers was presented by some as a desirable pinnacle of social standing in the eyes of their families and communities. Similarly, SCTE lecturers displayed an overwhelming consensus that the use of learning technologies must be increased and expressed a unanimous commitment to reach a superior level of competence in using technology themselves. While very appreciative of hands-on training already received, they strongly requested more training opportunities.

Experiencing statistical analysis using Structural Equation Modelling (SEM) supporting a logical model of computer literacy, the “Model for Intention to Use, Confidence, Trust and Perseverance with Statistical Significant Standardised Regression Weights” (Esterhuizen *et al.*, 2012b), was rewarding. It was wonderful to see relationships appearing which confirmed support and an enabling environment, contributing to trust to attempt, which results in confidence. Confidence resulting from successful attempts to use relates to an intention to persevere. During the qualitative analysis of the responses, insights into lived experiences were precious. The “Model for Computer Literacy Learning Emotions” (Esterhuizen *et al.*, 2012c) emerging from the analysis is exciting and encouraging after pondering over the data for such a long time. The assistance of co-researchers in this journey is of special

significance since expert statistical analysis and psychological perspectives are invaluable to reach meaningful research outcomes.

A TEL integration framework being constructed at this point where SCTE is still using so few learning technologies provides me with a wonderful opportunity, but also with a huge responsibility: that of urgently developing TEL integration measures. The enthusiasm and commitment of SCTE students and staff make this a journey to look forward to in delight and expectancy. My priorities would be to continue building confidence through hands-on training of lecturers, the agents of adoption, and to introduce social networking tools and promote collaboration using LMS and cloud-based interactivity. With commitment to empowerment from the university as institution, developing SCTE lecturers' confidence in online learning facilitation should progress together with SCTE students' online learning skills. Sourcing, classification and application of open education resources (OERs) are priorities to enable expansion of *e-Education Resources Aggregation* in the *Environments* group of aspects. In line with the suggested TEL framework, I will be responsible for the *Support and Empowerment* to reach all the *Objectives* as shown in the framework.

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