

Contextual hypermedia glosses for facilitating English vocabulary acquisition and reading comprehension at a university of technology

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Thesis submitted for the degree *Doctor Philosophiae* in Curriculum Development at the Potchefstroom Campus of the North West University

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May 2017

It all starts here [™]

To what lies beyond: Dreams. And their realisation.
(Proverbs 16:9)

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- My Constant Companion and my constant companion. Bly ek’s klaar, sodat ek meer tyd saam julle kan spandeer.

ABSTRACT

This study investigated the usefulness of non-linear lexical hypermedia glosses for supporting English Second Language vocabulary acquisition and reading comprehension where glosses are integrated into electronic reading materials. Mayer's Cognitive Theory of Multimedia Learning was the theoretical framework guiding the study. A hypermedia glossing system was developed for the study and embedded in the virtual learning environment in use at the Tshwane University of Technology.

A Solomon four group experimental research design was used. The glossing system was deployed in a comprehension test administered electronically to the treatment groups. The control groups did not have glossing support available. The 415 participants in this study were drawn from the foundation programmes of the Faculty of Engineering and the Built Environment. Three data collection instruments were developed to collect data. All the participants completed a text-specific vocabulary test administered directly before, directly after and eight weeks after the treatment. They also completed the reading comprehension test, and 212 participants from the treatment groups completed a user experience survey. The survey was used to determine the perceived usefulness of hypermedia glosses for vocabulary acquisition and reading comprehension.

The study found no practically significant effect of glossing on vocabulary when measured either immediately after or eight weeks after the treatment. There was also no practically significant effect on reading comprehension. Neither the pre-test, nor the interaction of the pre-test on the treatment, had a practically significant effect on vocabulary learning or reading comprehension. Participants perceived the glosses to be useful for vocabulary acquisition and reading comprehension, with significant correlation between different aspects of perceived usefulness. This perception of usefulness of glossing was however not reflected in practically significant effects on estimated group mean scores for the text-specific vocabulary tests and reading comprehension test used in the study.

Making hypermedia glosses available for readers of academic texts is recommended, especially since readers perceive them to be useful, and they make their reading experience enjoyable. Language level of definitions should closely match the language ability of readers. Future research should be conducted under conditions where test anxiety is limited. A system for tracking gloss access should be used, so that gloss access can be matched to test performance on an individualised basis.

Keywords

1. Cognitive Theory of Multimedia Learning
2. English Second Language
3. Hypermedia Glossing

4. Perceived usefulness
5. Reading comprehension
6. Second language learning
7. Solomon Four Group design
8. Technology Enhanced Learning
9. Vocabulary acquisition

OPSOMMING

Hierdie was 'n ondersoek na die bruikbaarheid van nie-lineêre leksikale hypermedia-glosse om woordeskat en leesbegrip in Engels as Tweede Taal te ondersteun. Mayer se Kognitiewe Teorie vir Leer met Multimedia was die teoretiese raamwerk wat rigting aan die studie gegee het. 'n Hipermedia-glosseringstelsel is ontwikkel vir die studie. Dié is geïntegreer in die virtuele leeromgewing wat by die Tshwane Universiteit vir Tegnologie gebruik word.

'n Solomon vier-groep eksperimentele navorsingsontwerp is gebruik. Die glosseringstelsel is ontplooi in 'n begripstoets wat elektronies aan die toetsgroepe bedien is. Glossering was nie vir die kontrolegroepe beskikbaar nie. Die 415 deelnemers aan hierdie studie was afkomstig uit die grondslagprogramme van die Fakulteit Ingenieurswese en die Beboude Omgewing. Drie dataversamelingsinstrumente is ontwikkel om data in te samel. Al die deelnemers het 'n teks-spesifieke woordeskat-toets direk vóór, direk ná en agt weke ná die behandeling voltooi. Hulle het ook die leesbegripstoets gedoen, en 212 deelnemers uit die behandeling-groepe het 'n gebruikerservaring-opname voltooi. Die opname is gebruik om deelnemers se persepsie van die nutswaarde van hypermedia-glosse vir woordeskat-verkryging en leesbegrip te bepaal.

Woordeskat is onmiddellik en agt weke na die behandeling gemeet, maar geen prakties betekenisvolle effek van glossering is gevind nie. Daar was ook geen prakties betekenisvolle effek op leesbegrip nie. Nóg die voortoets, nóg die interaksie van die voortoets op die behandeling het 'n prakties betekenisvolle effek op woordeskat of leesbegrip gehad nie. Deelnemers het die glosse as nuttig vir woordeskatverkryging en leesbegrip geag, met 'n beduidende korrelasie tussen verskillende aspekte van nutswaarde. Hierdie persepsie van nutswaarde is egter nie weerspieël in prakties betekenisvolle effek op geskatte gemiddelde groeptellings vir die teks-spesifieke woordeskattoets en leesbegripstoets wat in die studie gebruik is nie.

Hipermedia-glossering behoort beskikbaar gestel te word vir lesers van akademiese tekste, veral aangesien lesers hulle nuttig ag, en dit hul leeservaring aangenaam maak. Die taalvlak van definisies moet so nou moontlik ooreenstem met die taalvaardigheid van lesers. Toekomstige navorsing behoort uitgevoer te word onder omstandighede waar toetsangs beperk word. 'n Naspoorstelsel vir glos-raadpleging behoort gebruik te word, sodat raadpleging op 'n individuele basis aan toetsprestasie gekoppel kan word.

Sleutelwoorde

1. Kognitiewe Teorie vir Leer met Multimedia
2. Engels as Tweede Taal

3. Hipermedia-glossering
4. Geagte nutswaarde
5. Leesbegrip
6. Tweede taal leer
7. Solomon Vier-groep ontwerp
8. Tegnologie-verrykte Leer
9. Woordeskafverkryging

DECLARATION

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

A handwritten signature in black ink, appearing to read 'G. Wissing', is positioned above a horizontal line.

Gerrit-Jan Wissing

6 April 2017

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for facilitating English vocabulary
acquisition and reading comprehension at a
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Ethics number:

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Yours sincerely

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LIST OF ABBREVIATIONS

CALL	Computer Assisted Language Learning
CTML	Cognitive Theory of Multimedia Learning
ELS	English Literacy Skills
ELSA™	English Literacy Skills Assessment™
ESL	English Second Language
EWPTM	English Word Power™
FEBE	Faculty of Engineering and the Built Environment
FL	Foreign Language
FVR	Free Voluntary Reading
HEI	Higher Education Institution
HMG	Hypermedia Gloss
L1	First or Home Language
L2	Second Language
LoLT	Language of Learning and Teaching
MMR	Mixed methods research approach
NWU	North-West University
QUAL	Qualitative research approach
QUAN	Quantitative research approach
SDS	Directorate: Student Development and Support
SRS	Success Rate Sub-Committee
TEL	Technology-enhanced learning
TUT	Tshwane University of Technology
UNISA	University of South Africa
VLE	Virtual Learning Environment
VST	Nation's Vocabulary Size Test

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 BACKGROUND TO THE STUDY

Internationally, governments and other stakeholders increasingly place pressure on Higher Education Institutions (HEIs) to improve students' persistence at, retention in and completion of their studies towards a qualification (Zepke & Leach, 2005). South African Higher Education is no exception, and persistence, retention, and completion are managed with care, as they have an important influence on funding. Subsidies from government depend on students' success rates, rather than on student enrolment (Boughey, 2003). South Africa's dismal record in this regard is illustrated by a Council on Higher Education study (2013:43, 45) in respect of the 2006 cohort (excluding UNISA) which shows:

- a forty percent attrition rate by the end of the prescribed minimum period of study,
- that only 27% of students graduated within the prescribed minimum period of study for their particular qualifications, and
- that only 48% of the students in the cohort graduated within five years, while it is estimated that 45% will never graduate.

According to Prof Jakes Gerwel (Pandor, 2006), it is important not only to broaden access to Higher Education (HE) to students disadvantaged by the legacy of apartheid education, but also to innovate teaching and learning so that it will improve the probable success rate for a significant portion of disadvantaged students.

At the Tshwane University of Technology (TUT), success rate is regarded as of great importance. Figure 1-1 illustrates how TUT has been languishing at the bottom of the national rankings with respect to the success rate of their students, hovering between the 20th and 22nd position out of 23 institutions (Centre for Higher Education Transformation, 2012). The institution is succeeding to some degree in improving graduation rates and is moving away from the lower end of the national success rate ranking.

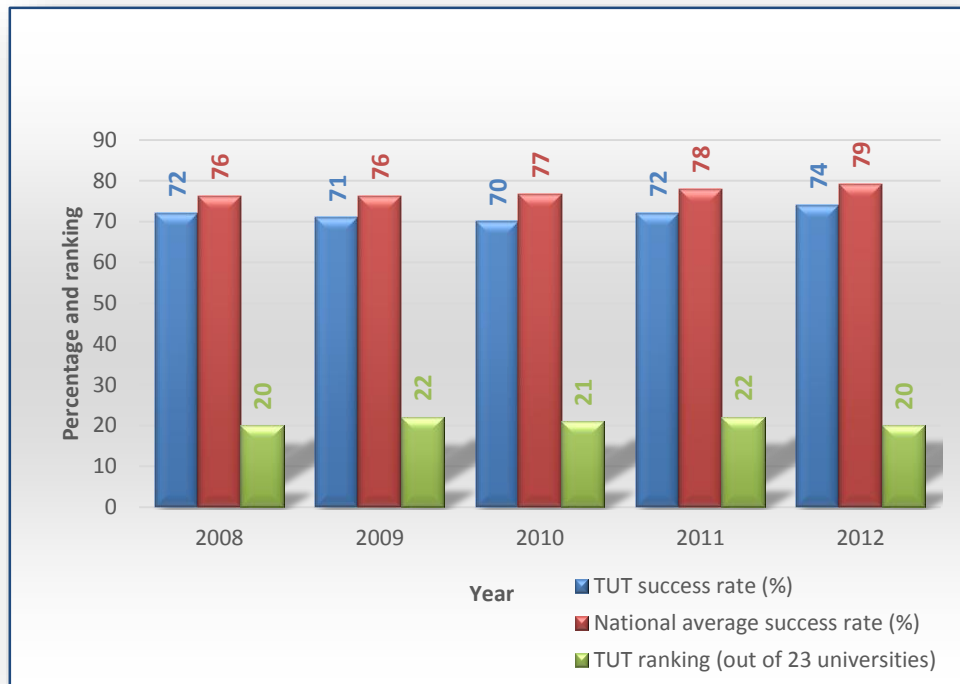


Figure 1-1: Success rates: TUT vs national average (Centre for Higher Education Transformation, 2012).

Pressure on financial resources demands that success rates improve, as such an improvement will in turn have a positive effect on government subsidy (Van Staden, 2009:1, 6, 13). Initiatives such as the Throughput Project were launched at TUT in 2006 (Tshwane University of Technology, 2009b:2) with the objective to promote the implementation of measures aimed at increasing the success rate at TUT. In October 2009, the Throughput Project was remodelled into the research driven Success Rate Sub-committee. A sub-committee of the Senate Committee on Teaching and Learning, it was constituted to continue the work done by the Throughput Committee. The naming of the Success Rate Sub-committee reflects the shift in focus away from throughput rate towards success rate, and has as objective promoting the implementation of measures aimed at increasing the success rate at TUT (Tshwane University of Technology, 2009b:2).

A number of factors, such as socio-economic background, lecturers' ability to facilitate learning, language of learning and teaching (LoLT) and students' readiness for academic study at tertiary level influence student success rates (Tshwane University of Technology, 2009a:2). The use of educational technology to support vocabulary acquisition and reading comprehension as important aspects of LoLT will form the subject of this study. While the official LoLT at TUT is English, for the majority of students and lecturers it is an additional language (Fowler & Van Staden, 2008:19). Consequently their proficiency in English is more than often underdeveloped, creating opportunity for miscommunication and misunderstanding.

Figure 1-2 summarises the results of a study performed at TUT during 2007, showing that only three percent of the 8 591 applicants who took the English Literacy Skills Assessment (ELSA) were proficient in English at a level of Grade 12 and higher (Dockrat, 2007:6).

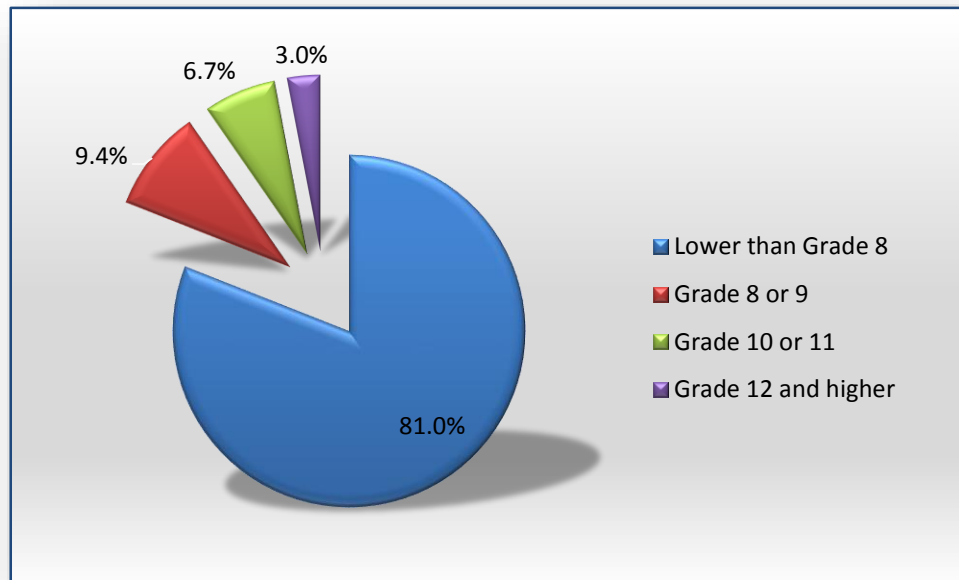


Figure 1-2: English proficiency of new applicants in 2007 (Dockrat, 2007)

Figure 1-3 shows that only 4,9% of the 2 165 first year students who took the ELSA was proficient in English at Grade 12 level and higher (Dockrat, 2007:11).

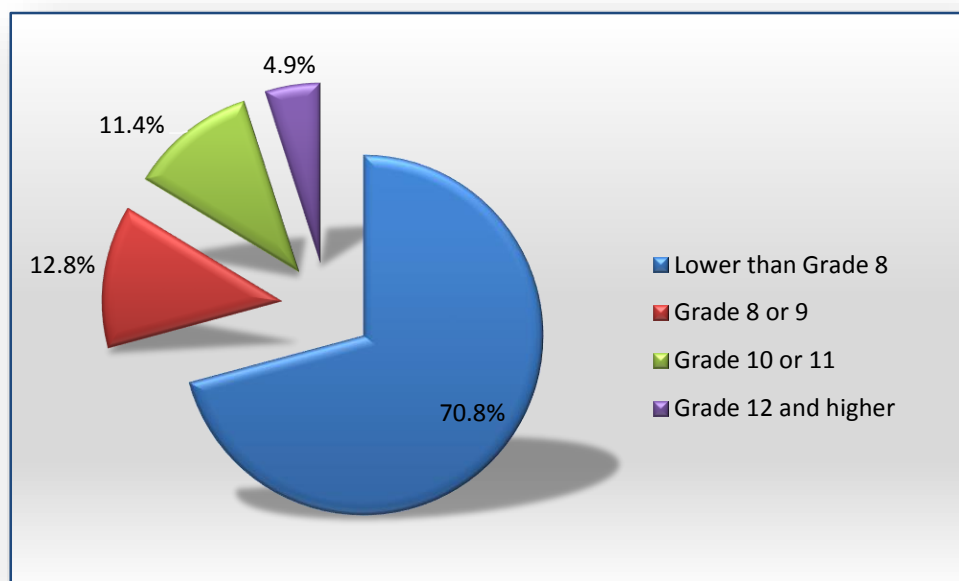


Figure 1-3: English proficiency of first year students in 2007 (Dockrat, 2007)

According to Dockrat (2004:2, 5), the average reading level of first year students at TUT was measured at 126 words per minute with sixty percent comprehension, while only 41% of students tested showed reading comprehension of seventy percent or better. A mere 0.03% of the students tested could read at, or better than, the norm of 280 words per minute with seventy percent comprehension used as criterion in the study.

Dockrat points out that this norm was set in 1960, indicating that it is now older than fifty years. The relevance of the norm for the current population is questionable. According to Owen and Taljaard (1996:37), a norm has to be set with reference to a representative sample from the population to which the norm is applicable in order to be valid. In addition, the norm was determined with reference to students at universities in the United States of America (USA), and no South African students were included in the study. Furthermore, for most of the students at TUT, English is not their home language. Due to these considerations, Dockrat cautions that the norm might not be appropriate for use at TUT.

1.2 PROBLEM STATEMENT

It is clear that the challenges pertaining to English as LoLT at TUT are significant. Meaning is expressed, conveyed and received through the vehicle of language. As English is the official LoLT at TUT, learning content is also in English. Limited vocabulary, weak grammatical skills and even differences in accent leave ample room for flawed understanding, ultimately hindering the achievement of learning outcomes. It is evident that a large portion of the student body at TUT has alarmingly underdeveloped English literacy skills (ELS). Furthermore, many of the lecturers employed at TUT are also not first language English speakers. Some are foreign nationals whose accents are difficult to understand. As English is the language of instruction, underdeveloped ELS will necessarily impact on the success rate of students. However, a dearth of resources, like support professionals, finances, and additional contact time, means that only a small portion of the need can be addressed along existing channels. While the TUT's Directorate for Student Development and Support (SDS) provides English language support, service provision is hampered by their limited capacity in terms of human and physical resources, the high rate of prevalence of underdeveloped English literacy skills among students, and the often voluntary nature of student participation in the services that SDS renders.

An innovative research-based approach is required, which would utilise the existing teaching technology infrastructure at TUT to improve student success through improved ELS without placing additional strain on already burdened human, financial and other resources. TUT's learning sites are geographically dispersed across four South African provinces, and draw students from across the country as well as from foreign countries, mostly those bordering on South Africa. Accessibility of the intervention over distance would therefore be an important success criterion.

1.3 PURPOSE OF THE STUDY

This study falls within the ambit of a broader initiative aimed at improving the success rate at TUT (Tshwane University of Technology, 2009b). The majority of both students and lecturers at TUT use English as an additional language. This has important implications for getting to grips with learning content, and for communication during the facilitation of learning.

Daily use of language is so connected to technology that using technology to learn language, especially ESL has become a “fact of life” (Chapelle, 2001:1). Van Wyk and Louw (2008:253) urge the use of computer technology to effectively and quickly address reading problems. While many questions about using computer technology for reading instruction remain unanswered, certain implications can already be drawn. The National Institute of Child Health and Human Development (2000:6, 8-9) mentions that computers have some motivational benefits above traditional instruction methods, and that hypertext and hypermedia have the potential to give readers some control over text presentation and to support readers experiencing reading difficulties. Their report foresees that developments in multimedia presentations and speech recognition may bring about even more successful future computer applications. They recommend the use of appropriate multimedia software where it is available.

Making use of technology-enhanced learning (TEL) shows potential for alleviating difficulties related to LoLT both inside and outside of academic classroom environments, for example by aiding the acquisition of general and subject related vocabulary (Yun, 2011:65). With this in mind, the purpose of the study is to investigate the effectiveness of Hypermedia Glosses (HMGs) on English Second Language (ESL) vocabulary acquisition and reading comprehension. HMGs should be designed so that they are readily available to, and accessible on demand by those requiring English language support at the point of need. HMGs should ideally not place an unmanageable additional strain on human, infrastructure, and other resources available at the university.

The purpose of this study is therefore to investigate the effectiveness of electronic glosses for supporting vocabulary acquisition and reading comprehension. The glosses to be examined include a combination of text and multimedia elements. These elements are drawn from word definitions, example sentences, synonyms, homonyms and homophones, L1 translations, L2 audio pronunciations, images, video clips, and animations.

While vocabulary acquisition is at the heart of this research, the study does not aim to make a contribution to the fields of Linguistics or Applied Linguistics. Instead, the inter-disciplinary study will focus on the use of educational technology, with the facilitation of vocabulary acquisition and reading comprehension as context.

1.4 THE CENTRAL RESEARCH QUESTION AND SUB-QUESTIONS

The central theme and thus the primary research question of this study can be framed as:

How useful are non-linear lexical hypermedia glosses for supporting English Second Language vocabulary acquisition and reading comprehension when glosses are integrated into electronic reading materials?

While the research question is multi-faceted, and unlikely to be exhaustively answered in this study, a number of sub-questions are attended to in order to contribute to addressing the main question. These sub-questions are:

1. How will non-linear contextual lexical HMGs accessible during an English reading comprehension task affect English vocabulary acquisition of readers?
2. How will non-linear contextual lexical HMGs accessible during an English reading comprehension task affect English reading comprehension of readers?
3. How will readers perceive the usefulness of non-linear contextual lexical HMGs accessible during an English reading comprehension task?

Vocabulary knowledge correlates strongly with reading comprehension, is regarded by some as central to literacy development and language comprehension, and is a strong predictor of academic success (Carroll *et al.*, 2011:2; Knight, 1994:285; National Institute of Child Health and Human Development, 2000:4.1-3). TEL in general and HMGs in particular could play a meaningful role in increasing vocabulary size and improving reading comprehension of students, in order to ultimately gain potentially significant improvement in student success rates.

1.5 RESEARCH APPROACH

The research question and sub-questions in this research are viewed through a pragmatic epistemological lens (Creswell, 2014:10-11). The nature of the questions dictates a quantitative approach—pre-test → intervention → post-test → delayed post-test and test group—control group designs—to gathering research data using quasi-experimental and non-experimental research. Participants will be drawn from students registered in a foundation programme offered by the Faculty of Engineering and the Built Environment (FEBE) at TUT. The research approach used to address the research question and sub-questions will be discussed in greater detail in Chapter Four.

1.6 SIGNIFICANCE OF THE STUDY

In the background to the study, a case was made for the importance of ESL interventions on international, national and institutional levels. ELS is particularly underdeveloped at TUT, to an extent and on a scale where available support systems cannot deal adequately with the challenge of facilitating the improvement of language skills. In such an environment it becomes important to find alternative approaches to supporting students whose discipline-related learning is impacted negatively by underdeveloped ELS.

Using computers to assist in language learning interventions has been well researched. For example: a bibliography of Computer Assisted Language Learning (CALL) studies produced by Jung (2005:135) contains details of 682 studies. Judicious use of learning technologies could have an important role to play in addressing the challenge presented by the underdeveloped ELS of students at TUT. Computer-based language learning (CBLL) interventions could provide language support to students while both inside and away from the classroom. Some of the challenges connected to the geographical dispersion of TUT campuses, such as equity of language support offerings across the multiple learning sites that make up TUT, can also be addressed by the implementation of appropriate learning technologies. This study will investigate the contribution that one such language learning technology could make towards supporting vocabulary acquisition and reading comprehension of students at a distance¹.

The uniqueness of the contribution of this particular study lies in the deviation from the approach of personally facilitated ESL interventions by language experts at HEIs, where specific computerised language learning software and face-to-face remediation are often used, to a language intervention within the context of the facilitation of a specific subject, embedded in the content of the subject itself. Such an intervention has a broader application than the face-to-face interventions currently on offer to often voluntary participants by the Directorate: Student Development and Support at TUT. The intervention will unobtrusively integrate into online or computer based subject content, and will be accessible both inside the classroom and at a distance, away from the classroom. It will increase the likelihood of improved ELS—specifically vocabulary and reading comprehension—ultimately to contribute to improved academic achievement of students without noticeable additional effort from academic support professionals, and without unduly detracting from the students' focus on the subject content (Taylor, 2006:315).

¹ The phrase *students at a distance* is used in distinction to *distance students* and refers to contact students during times when they are away from the classroom.

HMGs is a strand of CALL which shows promise in contributing to vocabulary acquisition and reading comprehension (Yanguas, 2009:61-62). Taylor (2006:309, 315) has shown a greater positive effect of L1 HMGs over L2 non-linear glosses on second language L2 reading comprehension, and cautions that glossing in L1 might be detrimental to deep processing of the text. The current study will concern itself with L2 glossing appropriately augmented with L1 translations. This approach is followed mainly for reasons of practicality. There are eleven official languages in South Africa and providing L1 glossing for all these languages, while possibly more effective, would be challenging. The approach is also an attempt to aid long-term acquisition of vocabulary through demanding greater attention and effort from the reader (Nation, 2001:175-176; Taylor, 2006:316; Wittrock, 1989:348; Yanguas, 2009:60). Enriching electronic texts with HMGs seems to contribute positively to both vocabulary acquisition (Chun & Plass, 1996a:194) and reading comprehension (Lomicka, 1998:41). HMGs appear to have definite benefits over traditional linear glosses (Lyman-Hager & Davis, 1996:784), and multimedia enriched HMG's appear to have the edge, especially in word recognition tasks, over text-only HMGs (Yanguas, 2009:61; Yoshii & Flaitz, 2002:33). It is, however, not yet clear whether different media types have different effects on vocabulary acquisition and reading comprehension. Research into the extent to which different media types used as components of HMGs contribute towards vocabulary acquisition and reading comprehension has yielded mixed results (Al Ghafli, 2011:6, 9).

Hypermedia glossing is proposed as a technology driven approach to supporting ESL and English for Specific Purposes vocabulary acquisition and reading comprehension in the field of Accountancy, a subject area where traditionally pass rates are relatively low among the large number of student enrolments. HMGs could alleviate the pressure on student support services who are facing a challenge with respect to underdeveloped English literacy skills, the magnitude of which would be difficult to address other than through a technology assisted approach. Such an approach could also be applied in other subject areas. Using HMGs presents the opportunity to avoid miscommunication between facilitator and student where both parties are communicating in their second language.

1.7 OPERATIONAL DEFINITIONS

1.7.1 L2

English is not the L1 of the majority of students at TUT. Often, with the students being multilingual, English is strictly speaking not even their second language (L2). For purposes of this research, though, English is referred to as the L2 whenever it is not the student's L1.

1.7.2 Literacy

While there is no one single definition of literacy, it is most commonly understood to refer to the ability to read and write (READ Educational Trust, 2010). This narrower definition indeed seems to be the meaning assigned to the term by the South African Ministry of Basic Education (National Education Evaluation & Development Unit, 2013:10-11). In a broader sense, literacy can be understood as:

the ability to use language and images in rich and varied forms to read, write, listen, speak, view, represent, and think critically about ideas. It enables us to share information, to interact with others, and to make meaning. Literacy is a complex process that involves building on prior knowledge, culture, and experiences in order to develop new knowledge and deeper understanding. It connects individuals and communities, and is an essential tool for personal growth and active participation in a democratic society (Expert Panel on Literacy in Grades 4 to 6 in Ontario, 2004:5).

Weideman (2003:7) provides a comprehensive definition for academic literacy. This definition frames academic literacy as the construct to be tested during academic literacy placement tests at tertiary level.

It requires of students to be able to:

understand a range of academic vocabulary in context; interpret and use metaphor and idiom, and perceive connotation, word play and ambiguity; understand relations between different parts of a text, be aware of the logical development of (an academic) text, via introductions to conclusions, and know how to use language that serves to make the different parts of a text hang together; interpret different kinds of text type (genre), and show sensitivity for the meaning that they convey, and the audience that they are aimed at; interpret, use and produce information presented in graphic or visual format; make distinctions between essential and non-essential information, fact and opinion, propositions and arguments; distinguish between cause and effect, classify, categorise and handle data that make comparisons; see sequence and order, do simple numerical estimations and computations that are relevant to academic information, that allow comparisons to be made, and can be applied for the purposes of an argument; know what counts as evidence for an argument, extrapolate from information by making inferences, and apply the information or its implications to other cases than the one at hand; understand the communicative function of various ways of expression in academic language (such as defining, providing examples, arguing); and make meaning (e.g. of an academic text) beyond the level of the sentence.

1.7.3 Reading level

For purposes of this study, reading level refers to a combination of reading speed and reading comprehension (Dockrat, 2004:2).

1.7.4 Success rate

Success rate refers to the number of subjects passed during a given year as a percentage of the subject enrolments, including cancellations, for that year. The success rate norm set by the South African

Department of Higher Education and Training is currently set at eighty per cent (Centre for Higher Education Transformation, 2012; SRS, 2010:6).

1.7.5 Technology enhanced learning

Technology-enhanced learning (TEL) refers to the use of digital technologies to support and enhance human learning (Chan *et al.*, 2006:7). Learning occurs when knowledge is integrated into long-term memory structures through processing it cognitively. This learning results in new understandings, skills and attitudes. For digital technologies to effectively enhance and support learning, care has to be taken to utilise these technologies in a manner that takes cognisance of the architecture of human cognition. Technologies that can enhance learning includes, but are not limited to, electronic games, virtual learning environments (VLEs), the World-Wide Web and certain electronic devices such as computers and mobile phones (Dror, 2008:215-216).

1.8 ORGANISATION OF THE STUDY

The study will comprise six chapters, and a reflective epilogue.

Chapter One: Orientation to the study

In this chapter the context for the study is provided. The research problem is mapped out and the purpose of the study is elucidated. The central research question is posed, and sub-questions—aimed at contributing towards answering the central research question—are framed. The significance of the study is explained, a number of key terms used in the research report are defined and the structure followed by the study is explained.

Chapter 2: Review of relevant literature

A comprehensive literature review is presented and a synthesis produced of the body of scholarship underpinning this study. The process of ESL and vocabulary acquisition is explored, and the important role of CALL is examined. Attention is paid to the forms and functions of glosses, focussing specifically on HMGs, as well as on their effect on vocabulary acquisition and reading comprehension.

Chapter 3: A hypermedia glossing system

A prototype web-based hypermedia gloss system was developed for the purpose of this study. It enabled participants to access the HMGs, and also recorded some of the aspects of participants' gloss access behaviour. In this chapter, the components and working of the system is described. A visual representation of the HMG design is shown, with a brief discussion of its relevant elements. Plans for future enhancements to the system are outlined.

Chapter 4: Research Approach

The researcher's epistemological stance is elucidated and the methodological approach to the study is expounded upon. The research design, including site and participant selection and instrumentation, is described. The chapter shows how data were analysed, and issues of reliability, validity as well as ethical considerations are addressed.

Chapter 5: Results

The results of the study are published in this chapter. Visual representations and discussions of data analysis are provided in response to the research questions posed.

Chapter 6: Discussion, limitations and recommendations, and conclusion

A summary of important findings from the study and conclusions drawn from those findings are provided. An explanation is given of how these findings relate to the research question. The significance of the study is discussed and limitations of the study are identified. Guidelines are drawn up to facilitate implementation of lessons learnt; these guidelines focus on the use of learning technologies in the process of facilitating vocabulary acquisition and reading comprehension. Finally, recommendations for future research are made.

Epilogue

The researcher reflects on his research journey.

1.9 CHAPTER SUMMARY

Inadequate English literacy skills is one of the factors affecting success rates at South African universities detrimentally. Specifically at TUT, the extent of underdeveloped ELS coupled with a scarcity of resources to address this pose a serious challenge with regard to student success rates. A research-based approach, addressing underdeveloped ELS within the constraints of limited human and financial resources, is sought. Supporting vocabulary acquisition and reading comprehension through the use of HMGs is proposed as a possible approach to addressing the challenge.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

2.1 INTRODUCTION

Nagel (2007:26) suggests a theoretical framework for online learning where the Learner-Content-Facilitator triad is connected by Learner-Content, Learner-Facilitator and Facilitator-Content interactions. These interactions are supported by a technological dimension consisting of software, communication networks and other technological issues. The current study argues that LoLT is another dimension which should be considered in online facilitation of learning, as language is the vehicle for making meaning during all interactions within the Learner-Content-Facilitator triad. Inadequate language skills will hinder these interactions. This investigation is specifically aimed at determining how the language dimension can be supported by the technological dimension.

The aim of this review is to construct a theoretical framework which will position the study within the existing relevant body of scholarly knowledge. It wishes to examine what others have already learnt about the research problem, and what has not yet been learnt but which could contribute to a better, deeper understanding of or even to a solution to the problem. It will lay a theoretical foundation for the study and provide reasons for why it may make a contribution to the development of the field of study (Babbie, 2015:118; North West University, 2011:418, 420).

2.2 THE IMPORTANCE OF LANGUAGE AND READING FOR THE LEARNING PROCESS

International research shows that the education of students with an L1 different to the LoLT is compromised; even more so when they come from a disadvantaged educational and socio-economic background. The issue of language is often complicated by students having sufficient L2 skills for interpersonal communication, but not for understanding and expression in academic contexts. Conversational fluency could easily be mistaken for L2 academic fluency, meaning that the need for developing of ELS to the point where learning content can be understood is not identified, and academic performance suffers as a consequence (Cummins, 2008:3). When weaknesses in L2 academic fluency are accurately diagnosed, the number of students requiring attention may be such that available human resources are insufficient. Intervention may then only be possible in a relatively small number of instances (Dockrat, 2007:6, 11).

In an academic environment, textbooks are still an important source of learning content (Cline, 1972:33; Jones, 2011:29; McFall, 2005:72; Phillips & Phillips, 2007:25). Written texts are however likely to be

written in academic language (Cummins, 2008:9), and the reader must be able to make meaning of those texts for the message contained in them to be conveyed (Smith & Taffler, 1992:84; Snyman, 2004:15). Bernhardt (2003:116) explains that first language literacy contributes twenty per cent to second language reading ability. Knowledge of the second language—mainly vocabulary knowledge—contributes another thirty per cent. The remaining fifty per cent may be contributed by factors such as interest in and engagement with the reading materials well as the purpose for reading. To these, Al Ghafli (2011:15) adds prior knowledge, the reader's cultural background and textual structure as matters influencing reading achievement.

Reading achievement can be much improved by implementing strategies such as strongly focussing on literacy engagement (Cummins, 2015:275, 277; Guthrie, 2004:1). The level of a reader's engagement with a text predicts reading achievement, allowing the engaged reader to overcome traditional barriers to reading achievement (Guthrie *et al.*, 2001:158). Reading comprehension of academic texts relies greatly on knowledge of the vocabulary used in the texts as the most important component of reading (Hu & Nation, 2000:404; Laufer, 2013:867; Laufer & Sim, 1985:405).

A large number of students at TUT are hampered by these traditional barriers to reading achievement (Tshwane University of Technology, 2009b:2), indicating the need for implementing strategies aimed at minimising the impact on learning due to coming from a disadvantaged background. The next sections turn to the importance of vocabulary knowledge for reading comprehension.

2.3 MODELS OF SECOND LANGUAGE READING PROCESSES

Chun and Plass (1997:61) differentiate between a reading components approach and metaphoric approaches to L2 reading. Bottom-up, top-down and interactive are the most prevalent of the metaphoric approaches.

2.3.1 Reading components approach

This approach subdivides reading into six component areas—automatic recognition skills, vocabulary and structural knowledge, formal discourse structure knowledge, content/world background knowledge, synthesis and evaluation skills/strategies and metacognitive knowledge and skills monitoring—which fluent readers are able to synthesize in a simultaneous, non-linear process into coherent mental representations of incoming verbal information; not as sentences but as conceptual content (Chun & Plass, 1997:61; de Beaugrande, 1982:180; Grabe, 1991:379; Just & Carpenter, 1980:333; Swaffar *et al.*, 1991:21-22).

2.3.2 Metaphorical approaches

Whereas lower-level bottom-up approaches focus on decoding the meaning of textual input through letter and word recognition, concept-driven top-down models place emphasis on prior knowledge of and interpretation by readers (Chun & Plass, 1997). Interactive models rely on several sources of linguistic knowledge, with deficiencies at a concept-driven level being compensated for by relying more on lower-level sources, and vice versa. Good readers are distinguished from weak readers by their ability to engage both approaches simultaneously (Stanovich, 1980:33).

In exploring Widdowson's (1983:40-40, 57-58) model, Fulcher (1998:283-285) describes reading as an interaction on three levels: between schematic knowledge shared by the reader and the writer (schematic level), the reader's linguistic competence (systemic level), and the actual process followed by the reader to interpret the schemata contained in the text with reference to his own existing schemata (procedural level).

Widdowson (1984:169) explains this reading process to include both the author and the reader, and describes reading as not an ability separate from other language abilities, but an instance of the general interpretive process underlying communicative activities. When reading, the reader interprets textual clues to create at best a partial understanding of the meaning of a text. Reading is not simply a reactive decoding of meaning explicitly captured in a text. It also encompasses an imprecise set of clues inserted into the text by the encoder, which direct the decoder to the place in her/his knowledge and experience where (s)he should look for the encoder's message. Reading is an interaction between a decoder and an encoder participating in a discourse. Reading requires the decoder to participate actively by following textual directions; decoding is successful only to the extent that the decoder is able to successfully follow these directions. The amount of information contained in a text cannot be calculated as it depends on the reader's knowledge and how much information (s)he wishes to extract from it, which in turn depends on the reader's purpose for reading the text.

Plass *et al.* (2003:227) suggest that glosses designed to help readers understand word meanings could be useful in supporting bottom-up reading processes. Glosses designed to aid integration of propositions contained in a text into readers' existing schemata might similarly be useful to support bottom-down reading processes. Giving readers control over HMG access allows them to customise the support provided by the HMGs while making meaning of a text (Erçetin, 2003:279; Taylor, 2009:153), and may even support the interaction between bottom-up and top-down processes.

Based on literature (Hu & Nation, 2000:404; Qian, 1999:299; Stahl, 2003:241), Figure 2-1 illustrates the interactive relationship between vocabulary acquisition and reading comprehension, and how both

vocabulary acquisition and reading comprehension may possibly be supported by implementing HMGs (Liu *et al.*, 2002:260).

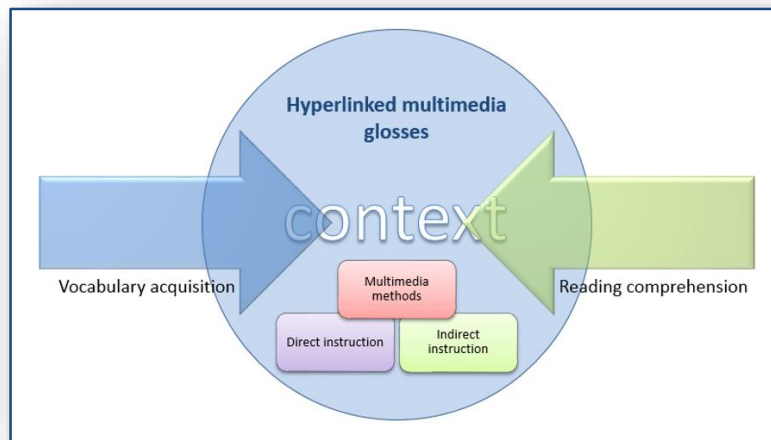


Figure 2-1: Implementing lexical hypermedia glosses to facilitate the interaction between vocabulary acquisition and reading comprehension. (Derived from Hu and Nation (2000:404); Qian (1999:299); and Stahl (2003:241))

As vocabulary grows, reading comprehension improves, which in turn facilitates the acquisition of new words. Vocabulary is normally acquired through direct instruction, indirect instruction and multimedia methods. HMGs combine these three instructional methods into a learning technology which, when embedded in a web-based application, is accessible from within the context of electronic learning material wherever one can access the Internet, whether that be from within or outside of the classroom. Glosses in general, and contextual HMGs in particular, have been shown to then aid reading comprehension (Lomicka, 1998:41; Taylor, 2006:310) and vocabulary acquisition (Chapelle, 2001:71; Taylor, 2006:310).

2.4 THE IMPORTANCE OF VOCABULARY FOR LANGUAGE AND READING

Vocabulary acquisition is often regarded as central to literacy development and language comprehension (Carroll *et al.*, 2011:2; Knight, 1994:285). A strong correlation exists between vocabulary knowledge and reading comprehension (Carroll *et al.*, 2011:2; National Institute of Child Health and Human Development, 2000:4.1-3). Vocabulary size is also a strong predictor of educational success (Carroll *et al.*, 2011:2). Biemiller (2001:1) suggests that there is an association between vocabulary acquisition and socio-economic status, with the vocabulary of disadvantaged students being compromised by having less opportunity for learning new words. The underdeveloped English vocabulary knowledge often found in non-native English speakers may negatively influence their understanding of written and oral information, which in turn might hinder the achievement of full academic potential (Hutchinson *et al.*, 2003:30).

Overwhelming evidence exists that good readers often read more and have better vocabulary, knowledge of the world, and reading ability than weak readers (National Institute of Child Health and Human Development, 2000:2.12). Smith (1941:328) shows in a seminal study that high-vocabulary grade 12 learners know up to four times as many words than low-vocabulary learners in the same grade.

Although the empirical evidence of a causal relationship between vocabulary learning and reading comprehension seems to be growing, it is still too limited to reach a firm conclusion (Anjomshoa & Zamanian, 2014:91; Lubliner & Smetana, 2005:189; Mokhtari & Niederhauser, 2013:164; National Institute of Child Health and Human Development, 2000:4.15; Quinn *et al.*, 2015:160, 171; Stanovich, 1986:379). This may be because the relationship is in fact not causal, or because vocabulary instruction is tied to the texts in which it is taught and does not transfer to differing texts or even, as Pearson, Hiebert and Kamil (2007:283) posit, that our measurement of vocabulary is not sensitive enough to establish such a causal relationship.

2.5 HOW VOCABULARY IS ACQUIRED

Pre-school children learn their first language predominantly through ordinary conversation. After entering school, this is no longer the case, and language needs to be developed through reading and explicit teaching of new words. Vocabulary is acquired incrementally, irrespective of whether words are learnt incidentally through reading, or through direct instruction. Both direct and indirect approaches to teaching vocabulary should be followed. Vocabulary is remembered better when encountered frequently in multiple, rich, meaningful, authentic contexts, using a variety of instruction methods which encourage active student participation rather than in isolated formats, such as lists. Pre-instruction of vocabulary needed for a specific text can aid vocabulary acquisition and reading comprehension. Restructuring of reading tasks to facilitate vocabulary acquisition and reading comprehension has also been used to good effect, especially with low-achieving or at-risk students (Beck *et al.*, 2013:3, 5; Carroll *et al.*, 2011:2; Nagy, 2010:73, 83; National Institute of Child Health and Human Development, 2000:4.3).

The National Institute of Child Health and Human Development (2000:4:17-18) presents a simplified preliminary taxonomy of vocabulary instruction methods, comprising the dimensions of explicit instruction, indirect instruction, multimedia methods, capacity methods and association methods. The first three dimensions are encountered when HMGs are used to support vocabulary acquisition and reading comprehension. As HMGs are central to this study, these three dimensions are subsequently discussed in greater detail.

2.5.1 Direct or explicit instruction

Vocabulary learning is facilitated by giving students definitions of selected words to be learned. An example would be pre-teaching of words required for a specific text (National Institute of Child Health and Human Development, 2000:4.3, 4.17). Beck *et al.* (2013:3) and Biemiller (2001:1) strongly advocate direct instruction, having found it effective for both increasing vocabulary and improving reading comprehension.

Nagy (2010:81), however, questions whether improved reading comprehension could be achieved for normal text without spending a significant amount of time in high quality instruction for every new word learned. Another argument against direct instruction is that there are simply too many words to teach, leaving indirect instruction as the only viable option. Nagy and Hiebert (2011:388) propose that a theory of word selection be developed as basis for deciding which words to teach. Beck *et al.* (2013:9-10) approach this challenge by dividing words into three tiers:

- Tier one, comprising an estimated 8 000 word families, contains the most basic, widely known words, rarely requiring instruction.
- Tier two, comprising about 7 000 word families, contains words that are encountered frequently over a variety of domains. These words are ideally suited to direct instruction, as they can make a meaningful contribution to verbal functioning.
- Tier three contains words which are encountered very infrequently, and often within a specific domain. These words are best learned in the context within which they occur.

HMGs offer the ability to add to the richness of vocabulary instruction without requiring a corresponding increase in language expertise and time investment from the subject facilitator.

2.5.2 Indirect or implicit instruction

Printed words cannot be readily understood if they are not already in the reader's oral vocabulary. It is, however, possible to acquire vocabulary incidentally, from merely reading, by deriving the meaning of the words from the context in which the words occur. Vocabulary items, particularly non-noun and concrete words, can be learnt from listening to a text being read, especially when the reading is interactive. More words are learnt incidentally by those who start off with a larger vocabulary as they have a larger reference base as resource. Words occurring frequently in the text are remembered better. It is, however, not yet clear to what extent reading more is correspondingly more effective for expanding vocabulary (Nagy, 2010:76; National Institute of Child Health and Human Development, 2000:4.3, 4.21).

Krashen's Comprehension Hypothesis, manifesting in literacy as the Reading Hypothesis, claims that we learn to read by reading, because we learn vocabulary, spelling, grammar and writing style when we

understand what we read and hear. The Reading Hypothesis advocates free voluntary reading (FVR), sometimes referred to as extensive reading, which essentially means that readers are allowed to read because they want to, and not because they have to. FVR is claimed to be more effective than direct vocabulary instruction based on the Skill Building Hypothesis for improving vocabulary, reading comprehension and, in some subject areas, knowledge levels. For FVR to be successful, text input must be comprehensible² and interesting to the reader (Krashen, 2008:180; Krashen, 2010:47, 55, 57). A reader should be able to understand most—Biemiller (2001:1) suggests 95%—of the words in a text to be able to understand that text.

Beck *et al.* (2013:5), in their argument for direct instruction, counter that, in order for vocabulary to be expanded incidentally through reading, the student needs to read widely, have the ability to infer the meaning of a newly encountered word from the context in which the word occurs, and encounter the new word repeatedly. Even then only a small portion of all newly encountered words will be acquired. Biemiller (2001:1) suggests that as many as eighty percent of words known by grade 6 students are actually learnt through direct explanation of some sort, and not through incidental learning. Unfortunately, students with the greatest need for vocabulary expansion are also the ones who do not read widely, and have underdeveloped inferential skills, indicating a need for explicit teaching of new vocabulary in order to improve reading comprehension.

2.5.3 Multimedia methods

Multimedia has the potential to add richness to direct instruction of words and, when presented as HMGs, to support incidental learning of words in context. Vocabulary learning is facilitated using not only text, but also a variety of other media, such as audio, video, pictures, animations and hyperlinks (National Institute of Child Health and Human Development, 2000:4.3).

2.6 COMPUTER ASSISTED LANGUAGE LEARNING

Advances in computer hardware and authoring software make it easier to produce more sophisticated, better designed language learning software without requiring specialised computer skills. Such software brings tools which can aid in better language writing, such as grammar checkers, spellcheckers and readability indices to ordinary computer users. It makes possible synergies with research into educational technologies such as hypermedia and multimedia virtual learning environments (Chapelle, 2001:12-14).

² Krashen (2009:21) hypothesises that we move to the next level of language competence ($i + 1$) “only when we understand language that contains structure that is ‘a little beyond’ where we are now.” When we understand the meaning of a selected text, we will be able to learn the meaning of unknown words within the text from the context within which those words occur.

Since the introduction of CALL there has been a proliferation of computer software and online materials for language learners and facilitators of language learning (Al Ghafli, 2011:3).

Chapelle and Liu *et al.* noticed that the question was no longer “Should the computer be used in language teaching?” but rather “How can the computer best be used in language teaching?” (Chapelle, 2001:1; Liu *et al.*, 2002:261). A survey among researchers at the 2014 CALL conference in Antwerp reveals the perceived importance of a research informed focus on purposefully designing technology enabled language learning environments, using technology not for the sake of using technology, but grounding its appropriate use in extant research (Levy *et al.*, 2014:3-5). In a language learning context, computer technology should not be used merely for the sake of using technology, but in service of the principles of second language acquisition (Chun, 2007:248).

Topics that have been researched include computer-mediated communication, web-based instruction, culture, writing, vocabulary, reading, literacy, syntax/grammar, speaking, and listening. Whenever research reports have been read within a year after publication, computer-mediated communication, culture, vocabulary and reading attracted the most attention from readers. Research by Tozcu and Coady (2004:473) indicates significantly better performance in vocabulary acquisition, speed of word recognition and reading comprehension of students using a CALL tutorial when compared to students using traditional reading materials. In their meta-study on the use of computers in language learning Liu *et al.* (2002:259, 261) point out that the use of multimedia in the design of authentic learning experiences appears to be the central CALL research interest. They remark on the importance of research into how HMGs can support vocabulary acquisition and how vocabulary acquisition can support reading comprehension. This confirms the potential of CALL programs for language learning.

There are indications that digitised vocabulary instruction is more effective than traditional methods. Learning technologies bring the potential for more practice and learner control (Dhaif, 1990:71), as well as the possibility to use multimedia in a variety of modalities, thereby improving effectiveness of vocabulary learning. The Internet also opens access to vocabulary learning resources (National Institute of Child Health and Human Development, 2000:4.3-4, 4.15, 14.22, 14.24, 14.26-27).

As one instance of digital learning technology to support vocabulary acquisition, glossing forms the focus of the present study and is discussed next.

2.7 GLOSSES

A gloss, or annotation, is a short definition or explanation, typically provided for unfamiliar words in a text (Lomicka, 1998:41). Glosses are easier to use than paper dictionaries, they aid in focussing attention on the target word and its related meaning, and provide an immediate connection of a word to its meaning

(Nagata, 1999:469). A gloss can improve interaction with the text, improve the speed with which the reader can process the text and might make the text more understandable (Ben Salem, 2007:23). Roby (1999:96) provides a taxonomy of glosses, classifying glosses according to authorship, presentation, functions, focus, language and form. The taxonomy is set out in Table 2-1, and serves to illustrate that there is more to glossing than merely explaining difficult words.

Table 2-1: Taxonomy of Glosses (Roby, 1999:96)

I. Gloss authorship	
A.	Learners
B.	Professionals
1.	Instructors
2.	Materials developers
II. Gloss presentation	
A.	Priming
B.	Prompting
III. Gloss functions	
A.	Procedural
1.	Metacognitive
2.	Highlighting
3.	Clarifying
B.	Declarative
1.	Encyclopaedic
2.	Linguistic
a.	Lexical
i.	Signification
ii.	Value
b.	Syntactical
IV. Gloss focus	
A.	Textual
B.	Extra-textual
V. Gloss Language	
A.	L1
B.	L2
C.	L3
VI. Gloss form	
A.	Verbal
B.	Visual
1.	Image
2.	Icon
3.	Video
a.	With sound
b.	Without sound
C.	Audio (only)

Initially glosses took the form of explanatory notes scribbled in the margin and between the lines of a page by the reader (Figure 2-2), and only later started being used as teaching aids (Roby, 1999:94).

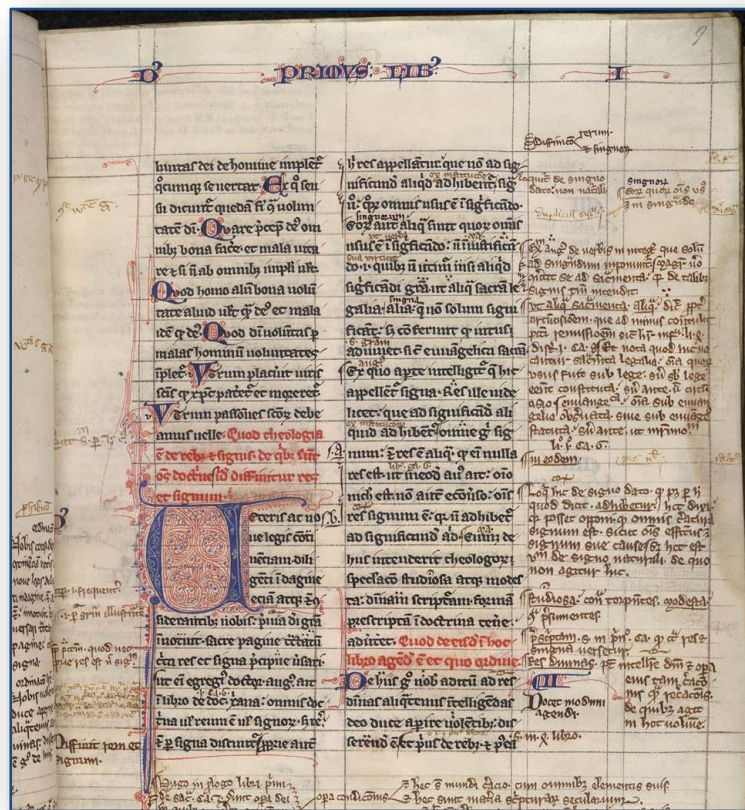


Figure 2-2: Handwritten inter-linear glossing and marginal glossing in an early manuscript (The British Library, 2005). © The British Library Board. Reprinted with permission. All rights reserved.

Paper-based marginal glosses (Figure 2-3) have been shown to significantly improve content recall when compared to a no-support condition. Marginal glossing is better for facilitating recall than support material presented prior to reading, but not significantly so (Davis, 1989b:44-45).



A man in evening dress, sitting in a cage at the zoo.

MAN (JOHN) And now for something completely different.

Pan to show 'It's' man in next cage.

IT'S MAN (MICHAEL)

IT'S...

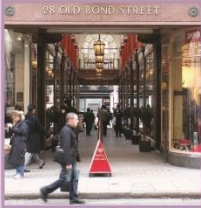
Animated titles.



Cut to studio: interviewer in chair.
Superimposed caption: 'FACE THE PRESS'



Bond Street is a shopping street in London's West End known for its highfalutin fashion stores. "Maxwell" is a fake store name.





More fashion fakery.

INTERVIEWER (ERIC) Hello. Tonight on 'Face the Press' we're going to examine two different views of contemporary things. On my left is the Minister for Home Affairs (*cut to minister completely in drag and a moustache*) who is wearing a striking organza dress in pink tulle, with matching pearls and a diamante collar necklace. (*soft fashion-parade music starts to play in background*) The shoes are in brushed pigskin with gold clasps, by **Maxwell of Bond Street** **1** The hair is by Roger, and the whole ensemble is crowned by a spectacular display of Christmas orchids. And on my right—putting the case against the Government—is a small patch of brown liquid...(*cut to patch of liquid on seat of chair*) which could be creosote or some extract used in industrial varnishing. (*cut back to interviewer*) Good evening. Minister, may I put the first question to you? In your plan, 'A Better Britain For Us', you claimed that you would build 88,000 million, billion houses a year in the Greater London area alone. In fact, you've built only three in the last fifteen years. Are you a bit disappointed with this result?

MINISTER (GRAHAM) No, no. I'd like to answer this question if I may in two ways. Firstly in my normal voice and then in a kind of silly high-pitched whine...You see housing is a problem really...

Cut back to the interviewer. The minister is heard droning on in the background. The soft fashion-parade music starts again.

INTERVIEWER Well, while the minister is answering this question I'd just like to point out the minister's dress has been made entirely by hand from over three hundred pieces of Arabian shot silk (*at this point we can hear the minister's high-pitched whine beneath the fashion music*) especially created for the minister by **Vargar's of Paris**. **2** The low slim-line has been cut off-the-shoulder to heighten the effect of the minister's fine bone structure. Well I think the minister is coming to the end of his answer now so let's go back over and join the discussion. Thank you very much minister. Today saw the appointment of a new head of...

4

Monty Python's Flying Circus

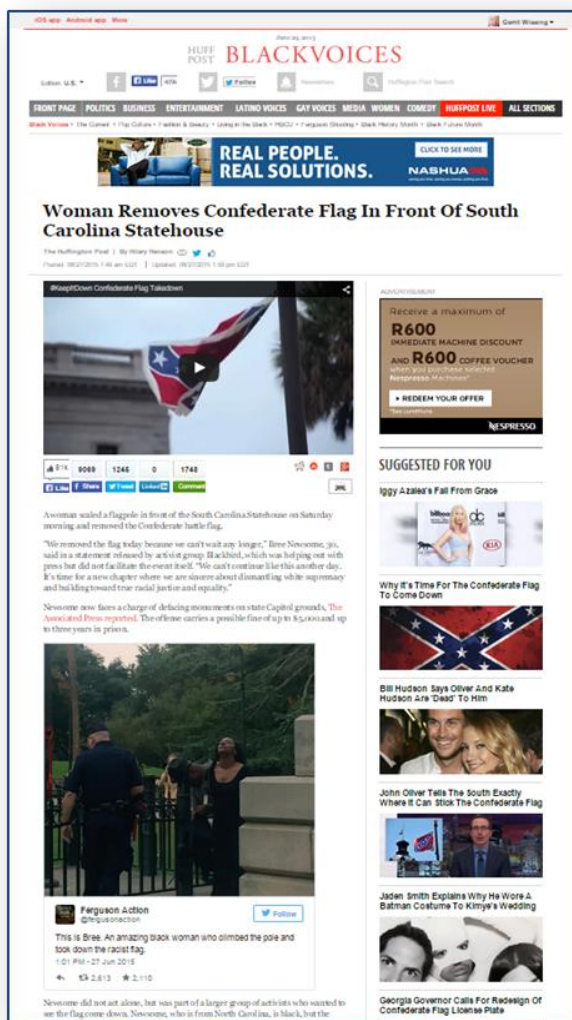
Figure 2-3: Linear multimedia marginal glossing in print format (Dempsey, 2012).

When compared to having no reading support, dictionaries and paper-based glosses decrease the time spent reading a foreign language (FL) text, though it may not improve reading comprehension (Roby, 1991:iii). These studies, however, still recommend the continued use of glosses to support FL reading. Hulstijn *et al.* (1996:336) found the use by readers of paper-based marginal glosses and dictionaries to find meanings of words re-occurring in a text to be superior to a no-gloss condition for incidental vocabulary learning. They remark that readers will often not use a dictionary to look up unknown words other than for short texts or for words which they consider relevant to the achievement of reading goals. For that reason, marginal glosses are of more value to readers than dictionaries in providing word meanings.

2.7.1 Hypertext and hypermedia glosses

Nelson (1965:13, 15) is attributed with first coining the term hypertext, meaning a “body of written or pictorial material interconnected in such a complex way that it could not conveniently be presented or represented on paper”. Films, sound recordings, and video recordings, arranged non-linearly with the use of a computer, may be very useful for educational purposes if properly designed by “increasing the student's range of choices, his sense of freedom, his motivation, and his intellectual grasp.” He refers to media referenced in this manner as hypermedia.

A gloss using multimedia such as pictures, sound and videos complementary to text (Figure 2-4), is known as a multimedia gloss (Chun & Plass, 1996a:183).



Multimedia glossing on this page includes:

- A linearly embedded YouTube video (The Tribe, 2015).
- Hyperlinks to related reports
- A photograph
- A linearly embedded tweet (Ferguson Action, 2015).

Figure 2-4: Electronic linear and non-linear multimedia online glossing (Hanson, 2015).

A non-linear multimedia gloss, connected to electronic text by way of a hyperlink embedded in a word contained in the text, is referred to in this study as an HMG (Figure 2-5). HMGs are useful in

accommodating individual differences in learning styles and strategies. They allow readers to personalise their learning by allowing them control over which words and information they select in their endeavour to construct meaning (Erçetin, 2003:279; Taylor, 2009:153). Yun (2011:12-13) lists authenticity, salience and non-linearity as appealing features of HMGs, with non-linearity allowing readers to adapt the use of glosses to their own requirements. It carries the added appeal of technology, the affordances of which learners find enjoyable (Dhaif, 1990:70-71; Messineo & DeOllas, 2005:51; Stepp-Greany, 2002:172).



Figure 2-5: Electronic non-linear multimedia online gloss proposed by this study (Thomas, 2015; Wikipedia, 2015).

HMGs are easily accessible while reading online texts, making them beneficial to online reading. An HMG requires a reader to select an unknown word in an electronic text by, for example, clicking on it, rather than looking the word up in a paper-based dictionary. Clicking on an unknown word could open a pop-up window containing a pre-defined definition or explanation of the selected word, reinforced by graphics, animations or sound. The instant explanations of unknown words provided by HMGs in a text being read, can potentially aid the student in understanding those texts (Nation, 2001:175). For ESL readers, such an HMG could contain a translation of the word in the home language of the reader.

HMGs focus the reader's attention on unknown words in a text and provide an immediate connection between a word and its meaning. Attention has an important influence on ESL receptive vocabulary

acquisition (Aust *et al.*, 1993:64; Nagata, 1999:469; Nation, 2001:175-176; Yanguas, 2009:60) and on reading comprehension (Wittrock, 1989:348). HMGs pop up over the electronic page being read, ideally not obscuring but contiguous to the unknown word, and they do not disrupt the reader's focus on the text. Students consider contiguity of the unknown word in a text and the related gloss to be helpful (Chun, 2001:391-392; Nation, 2001:175; Taylor, 2006:310).

2.7.2 Glossing and dictionary use in second language learning

Generally, more words are defined where HMGs are used than when paper-based glosses are used—this may also contribute to the frequency with which HMGs are accessed. More glossing is thought to contribute to correspondingly better comprehension. Where readers have control over which items to access, disruption to the reading process by drawing attention away from the text is minimised (Taylor, 2009:153-154).

Students have a tendency not to look up an unfamiliar word in a paper-based dictionary unless they perceive the word as being important for reaching reading goals, or unless it occurs frequently enough for the students to consider the word worthy of attention. When words are looked up repeatedly and with comparable frequency, the effect on incidental vocabulary learning is similar, irrespective of whether HMGs or a paper-based dictionary is used to look them up (Hulstijn *et al.*, 1996:336). Readers however prefer HMGs to paper-based glosses. HMGs are accessed more easily and efficiently, and readers use them more frequently than paper-based dictionaries for looking up corresponding unfamiliar words (Aust *et al.*, 1993:63; Roby, 1991:iii).

The effect of easier, more frequent access to word meaning, which is less disruptive to the reading process, may explain why Taylor (2009:153) finds, with regard to supporting L2 reading comprehension, that while 64% of readers with access to paper-based glossing perform better than without them, 81% of readers with access to hypermedia perform better than without them. This is consistent with the findings of an earlier study by Taylor (2006:309). Hypermedia glosses can be used fruitfully as part of L2/FL language learning (Roby, 1991:iii; Taylor, 2009:156).

HMGs are of central importance to this study. They incorporate direct instruction, indirect instruction, and multimedia methods into a single teaching technology.

2.7.3 Monolingual and bilingual glosses

Dictionaries used to support L2/FL learning could be monolingual or bilingual. A monolingual dictionary provides the reference word and a simplified explanation of the reference word in the L2/FL, while a

bilingual dictionary provides both an L1 translation and a L2/FL definition of the reference word (Al Ghafli, 2011:33; Aust *et al.*, 1993:66). HMGs are classified accordingly in this study.

According to Nation (2001:275), research on glossing shows that the choice between monolingual or bilingual glosses is not critical, as long as the glosses are clearly understood. In the context of direct vocabulary instruction Beck *et al.* (2013:171) recommend that translations of terms into L1 be provided to supplement vocabulary instruction for struggling students. Taylor (2006:314) considers bilingual glossing to be most effective for enhancing reading comprehension of an L2 text and observes a strong reader preference—also observed by others (Aust *et al.*, 1993:63; Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:61)—for bilingual glosses over monolingual glosses. This preference may have immediate understanding of the text in mind, rather than long term mastery of the language. Bilingual definitions may, however, result in learners relying too heavily on these L1 definitions, especially in an L2 classroom setting where learning in the L2 should be emphasised (Aust *et al.*, 1993:66, 71; Taylor, 2006:316).

2.8 USING HYPERMEDIA GLOSSES TO PROMOTE INCIDENTAL AND INTENTIONAL VOCABULARY LEARNING

Acquiring vocabulary incidentally through indirect or implicit instruction relies heavily on students reading extensively, which in turn is facilitated when reading is “fun”—readers should be allowed to choose their own reading materials from authentic, interesting printed or electronic texts (Krashen, 2010:47; Yun, 2011:38). Students can become frustrated by texts which are too difficult for their level of reading competence, and therefore text input should be comprehensible. This means that students should understand enough of the vocabulary used in a text to make sense of the meaning of the remaining unknown words (Biemiller, 2001:1; Krashen, 2009:21; Laufer & Ravenhorst-Kalovski, 2010:15). Where cues to word meanings are not provided, readers may however infer word meanings incorrectly (Hulstijn, 1992:123).

Davis and Lyman-Hager (1997:62) show an inverse relationship between course grade for a FL course and the number of gloss consultations when reading a text in that FL. The implication is that, whatever the effect of glossing on vocabulary acquisition and reading comprehension is, lower performing students stand to be impacted to a larger extent by glossing, as they will access glosses more frequently. The same can perhaps be said of L2 readers who have a strong tendency to access L1 translations when HMGs are provided (Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:61; Taylor, 2006:314). The ease as well as the frequency with which the meaning of unknown words can be accessed is likely to aid vocabulary acquisition though, considering that learning of unfamiliar words occurs incrementally and requires many encounters with them before they are fully known (Beck *et al.*, 2013:5). Hulstijn *et al.* (1996:336) find

support for the hypothesis that frequent accessing of a glossed term will have a positive effect on acquisition of that term into vocabulary, perhaps owing to the repeated direction of attention to that term (Nation, 2001:175-176; Wittrock, 1989:348; Yanguas, 2009:60).

This section briefly examined the mechanism by which HMGs are intended to support vocabulary acquisition and reading comprehension. Next, some findings of studies investigating the efficacy of HMGs for vocabulary acquisition and reading comprehension will be discussed.

2.9 STUDIES OF HYPERMEDIA GLOSSES

Liu *et al.* (2002:260) conclude that HMGs can assist those students who do not have adequate vocabularies by contributing meaningfully to vocabulary acquisition. They can also make a positive contribution to reading ability by providing in situ vocabulary support, thereby aiding students to make meaning of the texts with which they are presented in the tertiary academic environment. Yun (2011:65) concurs that HMGs have a strong positive effect on ESL vocabulary acquisition with the target second language not significantly influencing effect size. The immediate learning effect diminishes over time, but is not lost entirely (Al Ghafli, 2011:105; Ben Salem, 2007:85; Yoshii & Flaitz, 2002:46). Lomicka (1998:41) suggests that text comprehension is deepened when aided by computer aided HMGs in the form of images, sounds and text such as definitions, translations and grammatical notes. Chapelle (2001:71) confirms the efficacy of HMGs in acquiring vocabulary and aiding reading comprehension. While reading, students can click on unknown words to access vocabulary support provided by HMGs. Generally, learners seem to benefit from this interactional modification.

While these conclusions are broadly representative of what is considered to be the effect of HMGs on vocabulary acquisition and reading comprehension, a closer examination of related studies reveals a more complex picture (Yun, 2011:13), with a large measure of variability in findings hindering a cogent synthesis of previous research. This variability is illustrated in the following paragraphs with reference to a selection of some of these findings.

Students, when exposed to text-audio-picture glosses, prefer online delivery to paper-based delivery of glosses (Al Ghafli, 2011:102). Taylor (2006:309, 311) observes that when given an option, learners show a preference for glosses worded in L1 rather than L2, and also finds a significant positive effect of computer mediated L1 glosses on reading comprehension when compared to paper-based or no glosses while reading L2 texts. Chun (2007:242-243, 245) agrees that multimedia glossing has a positive effect on vocabulary acquisition, but finds no benefit of these to reading comprehension. In some instances glossing even has a negative effect on reading comprehension. Studies by Ariew and Ercetin (2004:237) and Sakar and Ercetin (2005:28) reveal that readers have a positive attitude towards HMGs, but show no

benefit of HMGs on reading comprehension. Instead, intermediate readers' comprehension suffers increasingly as more time is spent on video and graphic content in glosses.

Research does not show a combination of text and multimedia elements in glosses that would clearly be optimal for supporting vocabulary acquisition and reading comprehension (Al Ghafli, 2011:9, 105; Ben Salem, 2007:5). Yanguas (2009:60) finds a benefit of glossing over no glossing to both vocabulary acquisition and reading comprehension; no significant difference in vocabulary acquisition between different types of glosses; but a beneficial effect on reading comprehension of combination glosses above other types of glosses. He concludes that glosses affect vocabulary acquisition and reading comprehension differently. Jones and Plass (2002:546) find better recall of vocabulary and comprehension of text where both first language (L1) text and pictorial glossing were available during second language (L2) learning activities than where only L1 text or only pictorial glossing or no glossing was available, with pictorial glosses being more important than text glosses. According to Al Ghafli (2011:iv), online glosses containing text and dynamic pictures support comprehension more effectively than text-only glosses.

According to Yun (2011:22, 75), low proficiency learners stand to gain most from glossing although care should be taken when using more than one type of medium in annotations, as low-proficiency learners are not as likely to be able to deal with the cognitive load required by multimedia learning environments. Plass *et al.* (2003:221) qualify this by showing lower vocabulary recall for low-verbal and low-spatial ability readers where text is glossed visually. Their study shows the poorest reading comprehension where mandatory visual-only glosses are provided.

Plass *et al.* (2003:227) suggest that for glosses to promote vocabulary acquisition, they have to aid the learner in selecting relevant verbal and visual information and in integrating verbal meaning with visual representation in working memory, so that the meaning of the word becomes clearly understood and retained in the learner's vocabulary. To promote reading comprehension, glosses have to aid the learner to organise known words in a text into author intended propositions, and integrate these propositions into existing knowledge. Yeung *et al.* (1998:7), however, do not find evidence of a significantly differential effect for low expertise readers between glossing aimed at vocabulary acquisition and glossing aimed at reading comprehension.

Much research has already been done into the effectiveness of HMGs in promoting vocabulary acquisition and reading comprehension (Chun & Plass, 1996a; Chun & Plass, 1996b; Davis & Lyman-Hager, 1997). While there may be a broad consensus about the utility of HMGs for vocabulary acquisition and reading comprehension, there are still areas which need further investigation. Different theoretical

frameworks, research designs and test types used in the research projects, combined with a multitude of variables that may influence test results, hamper the synthesis of findings into generally applicable guidelines (Yanguas, 2009:52; Yun, 2011:70). More research is necessary to provide a clear picture of the conditions under which HMGs can be implemented optimally.

2.10 THEORETICAL FRAMEWORK FOR THE STUDY

In an electronic text, simply by clicking on an unknown glossed word, HMGs can supply readers with immediate contiguous additional information about the meaning of the word or the context in which it occurs. In doing so, HMGs mediate between reader and text, aiding the reader in making meaning of the text (Al Ghafli, 2011:27; Aust *et al.*, 1993:63).

In simple terms the multimedia principle proposes that learning occurs more readily from a combination of words and pictures than only from words. Consequently, HMGs combining complementary words and pictures, will enable readers to learn better from the gloss than when only words are used. Presenting learners simultaneously with words and pictures aids the integration into their working memories of verbal and pictorial representations, and fosters the generative processing necessary to move these newly integrated representations from working memory into long-term memory (Fletcher & Tobias, 2005:117; Kalyuga *et al.*, 2000:133; Mayer, 2011:99-100; Sweller, 2011:67-68). This principle seems to be especially applicable to low-knowledge learners, with the effect of the multimedia principle diminishing as levels of expertise increase—known as the expertise reversal effect (Kalyuga *et al.*, 2000:133; Sweller, 2011:67-68).

Mayer's (2011:80-82) Cognitive Theory of Multimedia Learning (CTML) (Figure 2-6) attempts to show how sounds and images both contribute to learning. Learning occurs when external representations, in the form of multimedia instructional messages such as a communicated by narrated animations, slideshow presentations or HMGs are presented to the learner. As the messages are perceived from the external representations, they are held briefly in sensory memory as auditory or visual sensory copies. By attending to specific sensory copies, the sounds and/or pictures are transferred to working memory where they are organised into coherent verbal or pictorial mental representations. These mental representations are then integrated with other new sounds and pictures, as well as existing knowledge structures from long-term memory, enabling the new content to be stored in long-term memory. The role that motivation and meta-cognition play during this process of multimedia learning is important. A learner's motivation provides the drive for making the effort required to engage in the process of making meaning, while metacognition guides and coordinates this process (Mayer, 2011:82).

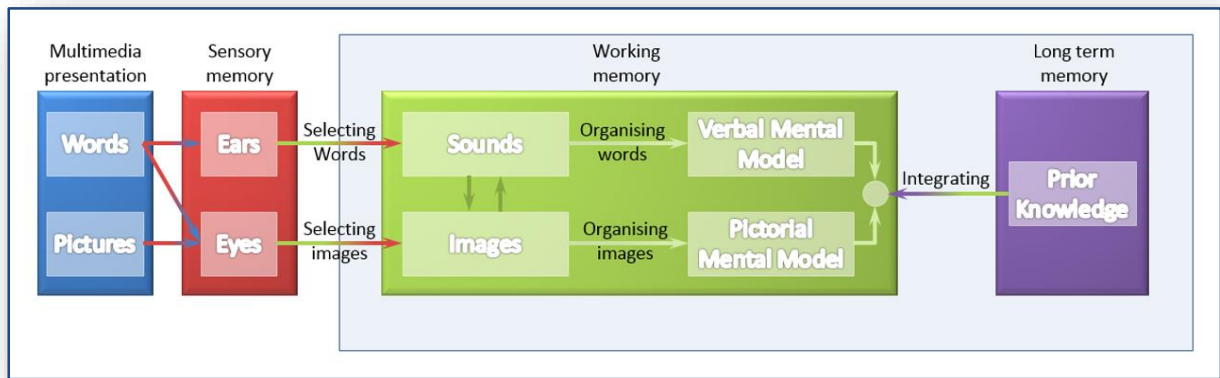


Figure 2-6: Cognitive theory of multimedia learning (Adapted from Mayer, 2011:81)

Functioning in tandem with the CTML, the Cognitive Load Theory mentions two sources of instructional load on cognitive resources. Intrinsic load is placed on cognitive resources due to the nature of the information itself. Extraneous load is placed on cognitive resources due to the way in which the information is presented (Sweller, 2011:57). Mayer's Triarchic Theory of Multimedia Instruction is derived from the Cognitive Load Theory. It identifies three types of demand on cognitive capacity, namely extraneous processing, essential processing, and generative processing. Extraneous processing, caused by poor instructional design, places an extraneous load on cognitive capacity. Information irrelevant to the learning task diverts cognitive resources away from the essential information. Essential processing, required to develop and organise mental representations of learning material, places an intrinsic load on cognitive resources. This load is determined by the level of complexity of the learning material. Generative processing—the processing required to make meaning of the learning material and to integrate it into long term memory structures—places a further intrinsic load on cognitive resources. The three goals of multimedia instructional design is then to reduce extraneous processing, to manage essential processing and to foster generative processing (Mayer, 2011:87-89).

Mayer further explains that the CTML rests on three principles: the dual channel principle, the limited capacity principle and the active processing principle.

2.10.1 The dual channel principle

The dual channel principle, derived from the Dual Coding Theory (Paivio, 2010:207), establishes that words and pictures are processed by separate but connected cognitive channels, viz. the auditory and the visual channels.

2.10.1.1 Dual channels and hypermedia glosses

A number of studies have confirmed, consistent with Paivio's Dual Coding Theory (2010:207) and Mayers' CTML (Mayer, 2011:81), the presence of a positive multimedia effect on vocabulary learning when both verbal and visual glosses were provided to readers (Plass *et al.*, 2003:236). The differentiated effect of visual only and verbal only glosses on vocabulary acquisition and reading comprehension provides further empirical evidence of both the existence and importance of two separate channels in working memory for processing of visual and verbal information (Plass *et al.*, 2003:239).

2.10.2 The limited capacity principle

The limited capacity principle holds that each channel has limited capacity for cognitive processing at any given point in time (Miller, 1956:80; Peterson & Peterson, 1959:198). This constraint on selecting, organising and integrating, is seated in working memory.

While in general learners learn better from words and pictures than from pictures alone (Fletcher & Tobias, 2005), the capacities of the auditory and visual channels are easily exceeded, resulting in worse rather than better learning. A narrated image or animation is most effective to present a combination of verbal and pictorial information, due to the two types of information—auditory narration and visual animation—entering working memory through two separate channels. Presenting narrated images or animations together with simultaneous display of the words of the narration on screen seems to result in less learning. A narrated animated presentation already comes at a high cost to cognitive resources, and the redundant on-screen text will cause working memory capacity to be exceeded. Retaining the on-screen text and removing the narration to remove redundancy is not likely to be effective, as it results in visual attention being split between the on screen text and images, and again learning suffers. This split attention hypothesis holds true where visual information progresses at a fast pace without the learner being able to control the speed of the presentation.

Presenting interesting but irrelevant information is also detrimental to learning: the emotional interest created does not lead to deeper learning of the learning material if the interesting information is not conceptually relevant to the learning material (Mayer *et al.*, 2001:195-196). While individual differences in learners' abilities, interests and prior knowledge play an important role in learning, differences in cognitive style have not been shown to have an influence on learning from multimedia presentations (Mayer, 2011:86-87; Riener & Willingham, 2010:33-34).

2.10.2.1 Limited capacity and hypermedia glosses

It would appear that different media types come at differing costs in cognitive load, which affect learners differently depending on their cognitive abilities. Providing visual and/or verbal glossing diverts cognitive

resources away from text processing. Readers rate graphical depictions of verbal descriptions highly for assisting in understanding meaning, but this highly positive perception of the usefulness of glosses, combined with the ease with which glosses can be accessed, may lead to excessive gloss use, causing split attention and redundancy. Inappropriate use of multimedia in glosses, such as presenting verbal information through both the visual and the audio channel can thus place an additional load on working memory, causing cognitive overload which in turn can hinder reading comprehension. The detrimental effect on reading comprehension is exacerbated when the reader is already challenged by constraints in cognitive resources (Sakar & Ercetin, 2005:28, 37). The limited capacity principle suggests that the effectiveness of glossing in promoting vocabulary acquisition and reading comprehension may suffer in such circumstances (Mayer, 2011:80-82; Plass *et al.*, 2003:231 et seq.).

Careful consideration of the effect of multimedia use when designing glosses is therefore necessary to promote the optimal utilisation of working memory capacity. The analysis of a single study by Plass *et al.* (2003) serves to illustrate just how complex the interaction between variables can become. Just two moderating variables (verbal ability and spatial ability), one treatment variable (gloss conditions), and two dependent variables (vocabulary size and reading comprehension), combine in producing a highly intricate set of findings:

- Compelling learners programmatically or otherwise to access all glosses may place a high load on cognitive resources. This effect on vocabulary acquisition varies with verbal and spatial ability of learners (Plass *et al.*, 2003:239). Mandatory glossing has a general multimedia effect on vocabulary acquisition, but low verbal ability learners receive less benefit from glossing containing mandatory visuals than from mandatory verbal only glossing (Plass *et al.*, 2003:232-233). Low spatial ability learners receive less benefit from mandatory visual only glossing (Plass *et al.*, 2003:233-234). High spatial ability learners are particularly hampered by having no glossing present, and receive less benefit from mandatory (visual + verbal) glossing than low verbal ability learners. These high spatial ability learners receive most benefit from mandatory visual only glossing, and only slightly less benefit from mandatory verbal only glossing (Plass *et al.*, 2003:233-234).
- Reading comprehension is neither promoted nor hindered by mandatory (visual + verbal) glossing when compared to no glossing when the glossing is designed to promote vocabulary acquisition rather than reading comprehension. Comprehension is hindered by mandatory verbal only glossing and mandatory visual only glossing, although the effect is only significant for mandatory visual only glossing. Reading comprehension is significantly weaker with visual only glossing than for any of the other conditions. Visual and spatial ability do not moderate this effect (Plass *et al.*, 2003:235, 237).
- When there is no glossing present, all cognitive resources can be focused on text comprehension. Mandatory visual only and mandatory text only glossing hinder reading comprehension, but

mandatory (visual + verbal) glossing, by visually illustrating a related verbal explanation, does not divert cognitive resources away from the task of text comprehension in the same way as the other two types of glossing, leaving cognitive resources free to focus on text comprehension, so that reading comprehension is not hindered when measured against a no-gloss condition (Plass *et al.*, 2003:237).

From the above, with only a few of the possible variables being examined, it would seem to be almost impossible to design an HMG intervention which would be beneficial to readers of all abilities. Two complementary strategies have, however, been suggested, which may still allow for the successful implementation of HMGs into electronic texts. They are learner control and instruction for appropriate gloss use.

2.10.2.2 Limited capacity and locus of control

Giving learners control over which glosses and which types of glosses to access rather than providing all available information by default may ameliorate the detrimental effect of redundancy, split attention and sub-optimal modality on cognitive resources by allowing them to selectively access only the support their specific abilities require, thereby minimising the detriment of cognitive overload (Plass *et al.*, 2003:236, 239; Sweller, 2011:62; Taylor, 2009:154). This could be particularly true if learners are made aware of their own cognitive constraints and strengths.

Findings by Chun and Payne (2004:497-499) suggest that giving the reader control over which glosses they access, could lead to them adapting their frequency of gloss access. Such a variation in access frequency then compensates for challenges they may encounter due to varying cognitive abilities, with low working memory capacity learners accessing glosses more frequently, and consequently benefitting more from glossing. Such modified access patterns seem to negate the individual differences in working memory capacity—more clicks leading to more learning—so that constraints no longer have a corresponding effect on vocabulary acquisition, reading comprehension and text recall (Beck *et al.*, 2013:5; Chun & Payne, 2004:497-499; Hulstijn *et al.*, 1996:336). Allowing readers to decide individually how much time to spend on reading, at what pace to read, and how to go about making meaning from the text and from gloss content, actively involves the readers in the process of reading and makes reading more meaningful for them (Erçetin, 2003:279).

2.10.2.3 Limited capacity and appropriate gloss use

Davis and Lyman-Hager (1997:62) find an increase in gloss access as language ability decreases, but no correlation between gloss access and reading comprehension. They explain their findings as caused by the inexperience of readers with computerised glosses. Another explanation could be that the difficulty

of the text itself overloads students' limited comprehension capacity to the point where a gloss is no longer useful. The results of their experiment seem to allow for Chun and Payne's compensatory access theory mentioned in the previous paragraph (Chun & Payne, 2004:497-499). The speculation about the inexperience of readers with glossing hampering their judicious use thereof, seems to support the recommendation for instruction in the use of glosses. Such instruction could allow users to exercise their control over gloss access in a way that will support vocabulary acquisition and reading comprehension (Davis & Lyman-Hager, 1997:68; Sakar & Ercetin, 2005:37).

This instruction could cover aspects such as knowing when to access HMGs (Venezky, 1994:51) and how to go about integrating the visual experiences and the related verbal experiences which are encountered when accessing HMGs (Bolter, 1998:4; Hedley *et al.*, 1994:116). Readers also need guidance on how to orient themselves in a non-linear HMG supported environment. Reading in such an environment implies leaving a text to access a hyperlink and then returning to the original page to resume the act of making meaning of the text. This interactional modification should occur in a manner which does not detrimentally affect the process of meaning making by the reader (Bolter, 1998:10).

Providing readers with training in the appropriate use of glosses, thereby enabling them to exercise their control over gloss access judiciously, could be the key to providing a level of HMG support appropriate to the reader's individual cognitive capabilities.

2.10.3 The active processing principle

Mayer (2011:82) describes learning as a combination of processes of selecting words and images from external presentations and organising them into coherent mental representations held in working memory, where cognitive engagement with the mental representations integrates them with each other and with long-term memory structures.

The active processing principle means that for meaningful learning to occur, the learner must actively engage in these learning processes as learning is improved measurably when learners engage with multimedia lessons in a way that involves deep processing, requiring learners to generate verbal or pictorial "representations" of their own understandings (Mayer, 2011:82, 100-101). This is consistent with the generative theory of learning (Wittrock, 1974:40) in emphasising the role of motivation of and attention paid by the learner in understanding and long-term memory (Wittrock, 1989:345), and has the implication that effectively designed instructional procedures can benefit understanding significantly (Wittrock, 1992:540).

Noticing and attention are said to be basic mechanisms for selecting words and images. These mechanisms are perhaps pre-conditional to aspects of second language acquisition such as vocabulary

acquisition and reading comprehension, with intention to learn perhaps playing a supporting role (Schmidt, 1995:17, 28).

2.10.3.1 Active processing and hypermedia glosses

Actively engaging with mental representations is necessary to move them from working memory into long-term memory. Where only a few words in a text are glossed, and the gloss is in the form of two possible translations of the target word, presented as multiple choice with correct/incorrect feedback, immediate word recall is better than where only the correct translation is provided. Choosing the correct meaning from two possibilities requires of students to pay more attention and to be more actively engaged cognitively, which results in better word retention (Hulstijn, 1992:123; Nagata, 1999:472, 474).

Yanguas (2009:55, 60-61) reports that learners, when provided with either text, picture or combination glosses, notice significantly more words than without glosses, with no significant variances between gloss groups. The mostly low awareness level of gloss access, by not distracting the readers' attention from the reading task, possibly explains the significant benefit to reading comprehension of gloss conditions above the no gloss condition—especially where text and pictures are combined in the glosses. It could also explain the decay in word recognition and production gains over a three week delayed test period.

While not presented as findings of the study, Yanguas (2009:55, 60) mentions that both the gloss and no-gloss groups seemed to be intent on understanding the text. This observed intention to understand might have been instrumental in students paying the necessary attention required to learn—attention being a basic mechanism in the process of language learning (Schmidt, 1995:7)—and might contribute to understanding why in this study all gloss groups significantly outperformed the no gloss group, with the combination gloss group even significantly outperforming the other two gloss groups, while in other studies no effect of glossing on reading comprehension had been found (Chun & Payne, 2004:497-499; Davis & Lyman-Hager, 1997).

2.11 CHAPTER SUMMARY

In this chapter the importance of language skills, reading ability and the influence of vocabulary for the learning process was examined. An overview in broad terms was provided of the development of reading skills, the role of vocabulary in reading and how vocabulary is acquired. Furthermore, the role computers can play in vocabulary acquisition was reviewed, with special attention being paid to HMGs and how they can influence reading comprehension and vocabulary acquisition.

A conceptual framework for implementing hypermedia glosses in the facilitation of vocabulary acquisition and reading comprehension was presented. This framework was used to provide a brief overview of the

cognitive processes involved when a learner learns from a multimedia presentation or, as is investigated in this study, an HMG. Understanding these cognitive processes brings an awareness that there is more to the multimedia principle than a simple “words + pictures > words only” and a focus on the latest available technologies for delivering media-rich and visually pleasing HMGs to the reader. A learner-centred approach requires that the implications of cognitive processes involved in multimedia learning be carefully considered when designing multimedia enriched HMGs to be used in the facilitation of vocabulary acquisition and reading comprehension (Mayer, 2009:3; Mayer, 2011:80).

In Chapter Three guidance for the development of a web-based hypermedia gloss system is drawn from previous studies. The prototype system developed for this study is described both from a system development and user functionality perspective.

A HYPERMEDIA GLOSSING SYSTEM

3.1 INTRODUCTION

A strong correlation exists between vocabulary size, reading comprehension and academic success (Carroll *et al.*, 2011:2, 9). Where ELS and academic success are not on par, a strong argument can be made for supporting vocabulary acquisition in order to strengthen reading comprehension and improve academic success (Beck *et al.*, 2013:3; Biemiller, 2001:1). While the role of HMGs on reading comprehension seems less clear, they could play an important role in expanding vocabulary, and some studies have shown a main positive effect of HMGs on vocabulary acquisition (Yun, 2011:65).

A hypermedia glossing system designed for the purpose of glossing electronic texts is fundamental to any research into the effect of HMGs on vocabulary acquisition and reading comprehension. In their research, Chun and Plass (1995:101) used Cyberbuch, a hypermedia learning programme used for learning German as foreign language. Other examples of glossing systems are The Interactive Annotated Reading Application (TIARA) (Center for Educational Resources in Culture, 2008), ClearText (Davis *et al.*, 1992), Annotext (Dartmouth College, 2015) and the discontinued Reading Toolbox (Ariew, 1999). In most of the studies surveyed, however, researchers developed application software customised to their research projects (Al Ghafli, 2011:53; Davis & Lyman-Hager, 1997:60; Yanguas, 2009). For this study, a multilingual glossing system allowing for contiguous pop-up glosses as well as containing custom text elements was preferred. Being able to integrate the system into Blackboard Learn™ allowed the use of the assessment tools embedded in the VLE for data collection. As none of the glossing systems mentioned above fulfilled all the requirements for this study, a bespoke HMG prototype with a working title of gwizz was developed. Developing the system in-house also allows the researcher to modify the software according to the needs of future research projects.

3.2 A HYPERMEDIA GLOSSING SYSTEM

The groundwork for this programme was laid by an earlier prototype, named Esiyikhulumayo. Nini na Nini, an isiZulu phrase meaning “The Language we Speak. Any place, any time.” The working title for the prototype was Esi, pronounced “easy” (Johannes *et al.*, 2003:627). The programme developed to enable glossing for the current study improves on the functionality of the earlier version by for example including a rudimentary system to track gloss access behaviour. The system can be deployed in the VLE used under institutional license at TUT—Blackboard Learn™—quite easily. The user has control over which glosses to access as well as over certain of the elements displayed in the gloss. The system also has limited

embedded functionality to record data in respect of participant behaviour with regards to gloss access in a log file.

The following sections describe the database containing the gloss terms, the gloss access log file, the script which brings all the elements of the system together, and the jshack building block which allowed the system to be deployed in Blackboard Learn™. Finally, the pop-up HMG itself is described, and plans for future improvements to the system are outlined.

3.2.1 Multilingual multimedia glossary database

The terms used to populate glosses are held in a MySQL™ database running on a remotely accessible domain server currently dedicated to hosting the HMG system. The multilingual multimedia glossary database was pre-populated for the purpose of the research project. For a given word, the database contains the fields for:

- The word in English.
- An explanation of the word in English.
- An example sentence in English illustrating the use of the word.
- An English word or words with meanings similar to the selected word as it is used in the specific context.
- An English word, words, or phrase indicating what the words do not mean in the specific context.
- A translation of the word in each of the remaining ten official South African languages.
- The name of the file containing an L2 audio pronunciation of the word in .mp3 format, e.g. for “tea” the filename would be “tea.mp3”. The file itself is contained on a separate folder on the server.
- Where appropriate, the name of the file containing a graphical illustration of the word in either .jpg or .png format, e.g. for “tea” the filename could either be “tea.jpg” or “tea.png”. The file itself is contained on a separate folder on the server.
- Where appropriate, the name of the file containing an explanatory video or animation clip of the word in .mp4 format, e.g. for “tea” the filename would be “tea.mp4”. The file itself is contained on a separate folder on the server.
- It is possible to define the gloss terms directly in the MySQL™ database, but it is easier to define them in Microsoft Excel™, then export them as a .csv file. The .csv file can then be imported into the MySQL™ database through a standard MySQL™ import functionality.

Guidance was taken from Beck *et al.* (2013:44) in deciding the form that text elements should take.

Elements were included to help students differentiate between similar words and interpret words with multiple meaning correctly in context.

3.2.2 Gloss definition

As far as possible, glosses were defined with reference to the meaning of the words in the context where they occurred. Only words which would mean the same in the specific context were provided as “Word(s) with similar meaning.” Instead of providing antonyms, “What the word does NOT mean here” was provided (Hulstijn, 1992:123).

A number of sources were used when populating the database. Definitions were mainly obtained from the online Oxford Dictionary (<http://www.oxforddictionaries.com>). Most of the words with similar meanings were obtained by right-clicking a word in MS Word™ and then accessing “Synonyms.” Where the list of synonyms was not adequate, the thesaurus accessible from the end of the list of synonyms was consulted. Audio clips were almost exclusively obtained from the Google web speech application programme interface (by using the string <http://ssl.gstatic.com/dictionary/static/sounds/de/0/xxx.mp3>, where “xxx” signifies the word being glossed). Images were sourced through Google™ image searches and, where necessary, modified using the GIMP™ image manipulation programme or Microsoft PowerPoint™. Videos and animations were sourced through Google™ video or animated .gif searches. Some animations were created using Microsoft PowerPoint™. Necessary modifications to animations and videos were made using Camtasia Studio 8™ screen capturing and video editing software suite by Techsmith™. The translations were provided by WITStranlate, the professional translation service provided by Witwatersrand University’s Language School.

An illustration of an HMG is provided in Figure 3-1.

3.2.3 Gloss access log file

Davis and Lyman-Hager (1997:69), in reporting their use of a “query log” to track users’ gloss access behaviour, recommend that the relationship between gloss use and reading comprehension be investigated further. In this study, user behaviour was logged in a MySQL™ log file in which the following information is recorded in respect of each word accessed:

- The Blackboard Learn™ username of the person accessing the gloss, obtained from a Blackboard Learn™ login memory variable.
- The word accessed.
- The date and time the HMG is accessed.
- The date and time the HMG is closed.

The recorded research data can be extracted directly from the log file in the database and exported in .csv format, which can be opened in Microsoft Excel™. In Microsoft Excel™, additional statistics on which words have been accessed (Aust *et al.*, 1993:67; Davis & Lyman-Hager, 1997:60), how many times each

word is accessed per participant and in total (Ben Salem, 2007:58), how many words are accessed per participant, and the duration of each access (Ben Salem, 2007:58) can be calculated easily. Comparing user access statistics to vocabulary gains and reading comprehension scores could provide valuable information regarding the relationship between gloss access, vocabulary acquisition, and reading comprehension (Chun & Payne, 2004:497-499).

3.2.4 Pop-up hypermedia gloss script

The tool was first developed to run on pages hosted on a domain server. The enabling script itself, written in a combination of html, jquery, xml and php, is hosted on the domain server. The tool is easily deployed by pasting a number of links into the head section of an html page hosted on the domain server. For the moment, the script only works on a Google Chrome™ browser. A working example can be accessed from TUT's ePedagogy server (<https://eped.tut.ac.za/gwizz/page.html>³).

A gloss is accessed by double-clicking an unknown word on an enabled web page. Double-clicking selects the word, which traps the word in a memory variable. The word, user ID and timestamp of the gloss access are recorded in the gloss access log file, and the memory variable is passed on to a database search. Currently, if the word is not defined in the database, the script simply ends, with no visible indication that the word is not in the database.

If the word does exist in the database, an xml object is created containing all the components required to be displayed in the gloss. A pop-up modal is called, and the English text values held in the xml object are displayed in the modal. Media elements are made accessible through appropriate icons in the modal. If a text element is not defined in the database, a value of "n.a." is displayed in the modal. If no filename is contained in the media fields of the word's record in the database, the corresponding icon is not displayed. A translation of the word in one of the ten remaining official South African languages is accessible through a drop-down language selection list. The languages are listed in alphabetical order, which causes the default translation to be in Afrikaans. The modal has a cross in the top right hand corner, which implies that one has to click there to close the gloss, but in reality one can click anywhere on the screen to close the gloss. Closing the gloss records the timestamp in the gloss access log file, completing the record for the particular gloss access event. A limited number of variables can be controlled with some knowledge of html:

- The colour scheme of the gloss can easily be modified.

³ Until such time as a security certificate can be applied to the application, the first attempt to access this page will result in a "Your connection is not private" security warning. To enable the proper functioning of the HMG on the target page, click on "Advanced", then on "Proceed to eped.tut.ac.za (unsafe)". Failure to bypass the security issue in this manner will cause the HMG to not function properly.

- Modals typically appear on top of a semi-transparent full screen layer. This application also sits on top of a layer, but the layer has been set to full transparency. The level of transparency can however be modified.
- Any element of the gloss can be commented out in the script to prevent it from displaying in the gloss. In combination with the jshack building block discussed below, any element or number of elements can be isolated to test its effect on vocabulary acquisition and reading comprehension.

3.2.5 jshack building block

Using the gloss for research purposes, and specifically wanting to record participant access behaviour, brings with it the challenge of accurately recording user identification (ID) data. As soon as participants have to manually enter this information, the risk arises that the user ID can be entered incorrectly. A far more reliable approach would be to have participants log in to a system, and have the log-in validated against a user database. That, however, requires a validation routine and a pre-populated user database to be integrated into the glossing system.

In this project, a different approach was sought, and was found in integrating the glossing system into the Blackboard Learn™ VLE. The key to being able to do so was the jshack building block (Argo & Fuller, 2015), which allows a script to be injected into the Blackboard Learn™ VLE, and to be deployed virtually anywhere within the VLE.

This solution proved to be ideal, with Blackboard Learn™ having a built in log-in routine which validates the participants' user ID against a pre-populated user base during the log-in process. This validated user ID is captured by the HMG script, and used when recording access behaviour of participants in the gloss access log file.

3.2.6 Pop-up hypermedia gloss

For purposes of the intervention, almost all the words in the text used during the intervention were defined in the database and no visual signalling of glossed words was necessary. The absence of signalling reduces the probability of glosses being accessed simply because they are signalled, which could influence users' gloss access patterns (De Ridder, 2002:135).

The pop-up HMG is accessed by double-clicking on an unknown English word in an electronic document. Once a word is double-clicked, the gloss—as illustrated in

Figure 3-1—opens immediately to the top right of the unknown word, unless the word is too close to the right hand edge of the screen to accommodate the size of the pop-up. In such a case it aligns to the right

edge of the screen. Where the word is too close to the top of the screen, the pop-up opens below the word.

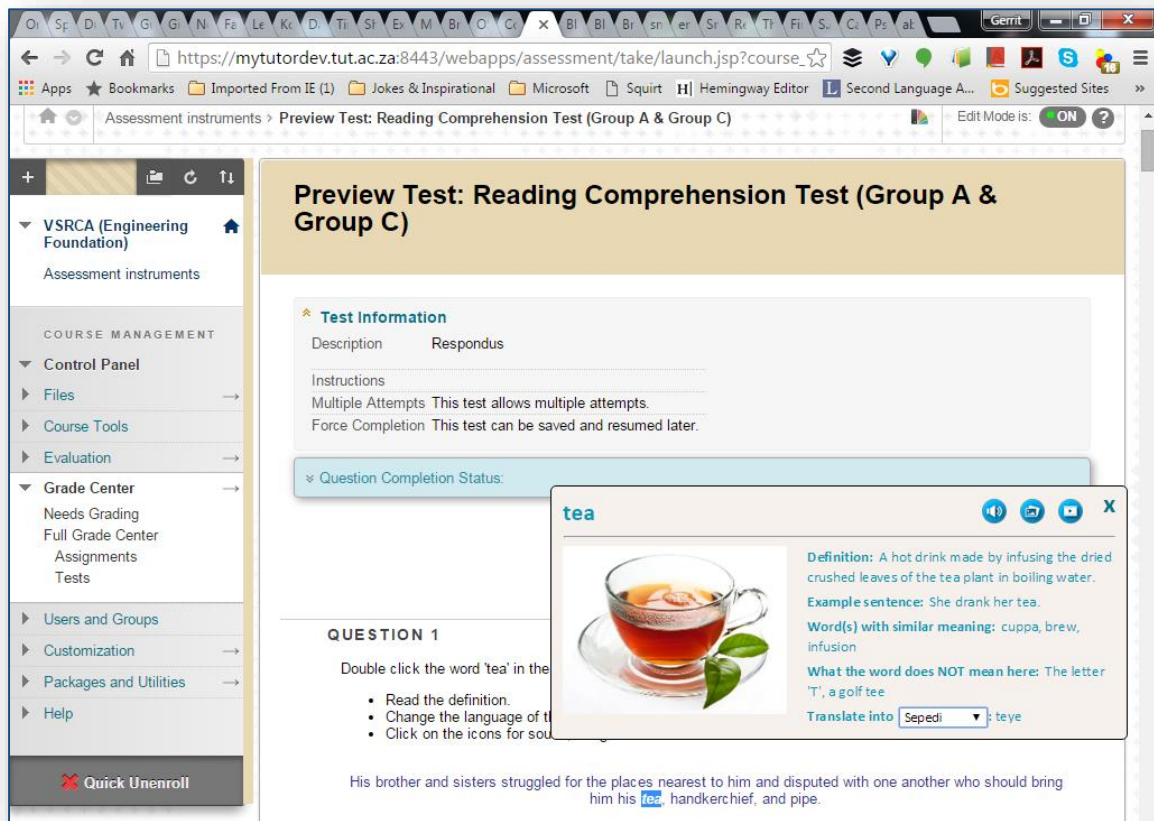


Figure 3-1: Screenshot depicting an HMG for the word “tea”

In the illustration, Sepedi is the selected home language. The illustration shows the HMG for “tea”, which contains:

- The selected word, “tea”, displayed in the top left corner.
- An icon linking to an English audio pronunciation of the selected word.
- Where available, an icon linking to an image illustrating the selected word.
- Where available, an icon linking to a video or animation illustrating the selected word.
- A definition of the word in English.
- An example sentence in which the selected word is used.
- A word or words with meaning similar to the selected word as it is used in the specific context.
- A word, words, or phrase indicating what the words does not mean in this context.
- The selected home language and a translation of the term into that language. Functionality is embedded allowing the reader to select the L1 from a drop-down list containing the ten other official South African languages, causing the L1 translation to be displayed in that language.

Non-linear bilingual pop-up glosses are used rather than linear marginal glosses. When the gloss is first accessed, only text elements are visible. Only once the image or video/animation icon is clicked does the related element become visible, as with the image of a cup of tea in the illustration above. In this manner, control over which gloss to access, how often to access glosses, which multimedia gloss elements to access, and how long to access them for, is handed to the reader. When this control is exercised judiciously, it might allow readers to manage their working memory capacity optimally, allowing them to adapt their access behaviour to their verbal and visual abilities (Chun & Payne, 2004:497-499; Davis & Lyman-Hager, 1997:68; Plass *et al.*, 2003:239; Sakar & Ercetin, 2005:37; Taylor, 2009:153-154).

Not all glosses contain all possible gloss elements. When all words in a text are glossed, it may not be possible to unambiguously illustrate some words—such as “value”—by way of an image or video/animation. Visual media were only used when it was considered appropriate to unambiguously illustrate the unknown word. Some illustrations contain both visual and text components. These combination glosses were used when text and visuals in isolation would possibly not convey the full meaning of the glossed word, but combining text and visuals would (Mayer, 2011:99-100).

A choice was made to provide text elements in English, as it would be impractical for the researcher to provide glossing in all eleven official South African languages. A concession to the multilingual composition of the group of participants was made by providing L1 translations of glossed words. L1 translations are considered to be helpful for students with underdeveloped ELS (Beck *et al.*, 2013:171), and readers show a strong preference for using L1 translations rather than L2 definitions (Aust *et al.*, 1993:63; Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:61). What is most important about the choice of gloss language is that the readers must understand the gloss (Nation, 2001:175).

3.2.7 Planned features

A number of features are still planned for future versions of the HMG system:

- An administrative user interface to facilitate the definition of gloss terms in, and the extraction of research data from the databases will be developed for a future version of the programme.
- Statistics should be accessible through a reporting function built into this administrative user interface. Examples of reports could include reports on which words were accessed, how many times each word was accessed per participant, how many times each word was accessed in total, how many words each participant accessed, and the duration of each access. At the moment, this has to be calculated in Microsoft Excel™ from the log file exported in .csv format from the MySQL™ database.
- The gloss access log file has to be expanded to include indication of which, if any, media files were accessed per word per participant.

- An option should be built in to signal words in a text for which glossed terms are available in the database. In this study, all words in the text were glossed, and signaling was superfluous. In an experiment where only some words of the text are glossed, signaling will probably be necessary, as participants would otherwise not know which words are glossed.
- Where a selected word is not defined in the database, the tool should redirect a database query to an open access dictionary. The definition for the unknown word should be harvested from there, written to the database, and from there the definition can be displayed in the HMG. In this way, the database can be made to be self-populating. Words so harvested can be flagged, so that a database editor can inspect the harvested definition to ensure that the language used in the definition is at a level appropriate to the intended users of the glossing system. As an interim measure until this feature is programmed, the pop-up should alert the reader to that fact that the word is not defined in the database, rather than the system simply being non-responsive.
- Currently, the system is only functional on Google Chrome™. Interoperability should be extended to Mozilla Firefox™ and Internet Explorer™ and/or its successor, Microsoft Edge™.
- The system should be adapted for use on mobile devices, focusing on the Android and iOS operating systems.

3.3 CHAPTER SUMMARY

In this chapter, the working and features of the hypermedia glossing system used in this research project were described, with indication of the direction further developments in the system might take. The research design followed in this study is described in the next chapter.

CHAPTER 4

RESEARCH APPROACH

4.1 INTRODUCTION

Chapter One provided the background to the study and stated the research problem and purpose of the study. The central research question and sub-questions were posed and the research approach was described in broad terms. In this chapter the research design will be described in greater detail, showing how the research question and sub-questions were addressed.

Creswell (2014:3) and Teddlie and Tashakkori (2009:4) identify three research communities within social and behavioural sciences. Research approaches in these methodological movements are given direction by an orientation towards quantitative (QUAN), qualitative (QUAL), or mixed methods research (MMR). They view QUAN and QUAL orientations not as “polar opposites,” but as the different ends of a continuum with MMR residing in the middle of this continuum. Creswell (2014:215) points out that MMR combines the strengths of QUAL and QUAN research to deepen understanding of the research problem.

While the researcher in this study identifies with the MMR community and its primarily pragmatic worldview (Teddlie & Tashakkori, 2009:4), the nature of the research question and sub-questions of this particular study indicated a purely quantitative approach. Using both experimental and survey research, numeric data were collected to deductively test some theories generated in previous studies into the effect of HMGs on vocabulary acquisition and reading comprehension for its applicability to the context from which participants were drawn (Babbie, 2015:23, 26).

Creswell (2014:5) mentions three interrelated components involved in a research approach. These are the researcher’s philosophical worldview, a research design that is suited to the researcher’s worldview, and the specific research methods that the researcher selects to carry out the research. The interconnection of these three components in the research framework for this study is illustrated in Figure 4-1.

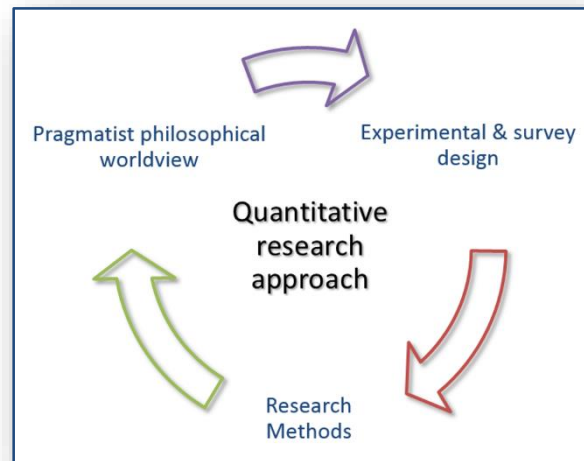


Figure 4-1: Research approach for this study, adapted from Creswell (2014:5)

4.2 PHILOSOPHICAL WORLDVIEW

As a skilled facilitator of online learning, I have experienced social constructivism at work. I have negotiated shared meanings with course participants, and benefited hugely from having my own constructs challenged and modified by others during those negotiations. But face-to-face social interaction, when not on a one-to-one basis, does not come to me naturally. I have to work hard at it, and will often go to great lengths to avoid it. I prefer, often to my own detriment, I fear, to work alone.

This research project has at its very heart the aim to transform and emancipate characteristics of pragmatism (Teddlie & Tashakkori, 2009:22), signifying a radical bent in the researcher's worldview. I have grown to consciousness during a period of civil strife in our country. While I do not believe I can fully understand the complexities prevalent in our society, I have come to realise that there are areas where I can participate to aid the emancipation of the marginalised, giving them voice and empowering them to improve their lives. Yet I tend towards impatience, and would prefer to do what I can on my own rather than having to spend time attending meetings trying to get buy-in from participants.

While I agree that the positivist "absolute truth" is an ideal—testing theories to refute, refine or prove them sounds logical to me—it is little more than an ideal, especially when engaging in social research. I do not think it is possible to objectively grasp the full richness of human experience. The area of learning in particular is exceedingly complex, with many possible causes for many possible outcomes. The literature review in this study serves as an example of this complexity by showing that individual differences in learners are important when HMGs are used. To find a practical solution to the real problem of generally low levels of ELS, it is necessary to understand these individual differences, for the very reason that a large-scale solution to the problem will have to cater for individual differences.

Burrell and Morgan (1979:ix, xi) proposes a framework for studying social theories. By counter-posing two sets of assumptions, they define four paradigms. Each of these paradigms has a differing set of prevalent assumptions related to the ontology, epistemology, human nature and methodology. This framework, illustrated in Table 4-1, is important when exploring other paradigms in order to fully appreciate one's own.

Table 4-1: Four paradigms for the analysis of social theory (Adapted from Burrell & Morgan, 1979:22-35)

The Sociology of Radical Change				
Subjective	Radical Humanist		Radical Structuralist	
	Ontology:	Nominalist	Ontology:	Realist
	Epistemology:	Anti-positivist	Epistemology:	Positivist
	Human nature:	Voluntarist	Human nature:	Determinist
	Methodology:	Ideographic	Methodology:	Nomothetic
	Radical + Ideographic		Radical + Nomothetic	
	Interpretivist		Functionalist	
	Ontology:	Nominalist	Ontology:	Realist
Objective	Epistemology:	Anti-positivist	Epistemology:	Positivist
	Human nature:	Voluntarist	Human nature:	Determinist
	Methodology:	Ideographic	Methodology:	Nomothetic
	Regulated + Ideographic		Regulated + Nomothetic	
	The Sociology of Regulation			

Burrell and Morgan (1979:25-26) situate academic sociology within a Functionalist paradigm. Enquiry within this paradigm tends to be highly pragmatic, aiming to understand society in a way which would allow for practical solutions to practical problems. This framework poses the four paradigms as mutually exclusive, disallowing for synthesis between more than one paradigm. While holding that over time differing paradigms may operate in sequence, synthesis of more than one paradigm at one specific point in time is said to be impossible.

The mutual exclusivity of this framework—what Coe (2012b:6) refers to as incommensurability—makes its use problematic to pragmatic researchers from the MMR community. To a large extent, these pragmatists do hold views consistent with the functionalist paradigm and associated worldviews such as positivism and post-positivism. They are however also moved by issues of social constructivism and advocacy or participatory knowledge claims with their radical humanist and interpretivist leanings. Table 4-2 provides an overview of the pragmatist worldview from the perspective of the MMR community.

Table 4-2: Pragmatism from a Mixed Methods Research Community perspective

Pragmatism	
Ontology:	Diverse viewpoints are held. Seeks to find the best explanations of social realities consistent with their personal value systems (Teddle & Tashakkori, 2009).
Epistemology:	Viewpoints can be objective or subjective, varying with the different stages of a research cycle (Teddle & Tashakkori, 2009).
Axiology:	Interpretation of results are value-laden (Teddle & Tashakkori, 2009).
Human nature:	Determined by actions and consequences of actions, rather than pre-existing conditions, which may exist but are fleeting and not easily identified (Creswell, 2014).
Methodology:	Ideographic, but still concerned with external validity issues and transferability of results (Teddle & Tashakkori, 2009).

Rather than regarding worldviews as mutually exclusive, Coe (2012b) offers pragmatism as an approach for reconciling a multiplicity in worldview. Abbas and Teddle (2003:713) define pragmatism as:

a deconstructive paradigm that debunks concepts such as “truth” and “reality” and focuses instead on “what works” as the truth regarding the research questions under investigation. Pragmatism rejects the either/or choices associated with the paradigm wars, advocates for the use of mixed methods in research, and acknowledges that the values of the researcher play a large role in interpretation of results.

This interpretation of pragmatism avoids taking a firm stance in the paradigm war by concerning itself with “what works” at the time. The problem, understanding the problem and solving the problem are important. Pragmatism should perhaps be viewed not as a philosophy, but as an anti-philosophical challenge to the notion of paradigms which is viewed as problematic and unhelpful (Coe, 2012b:8; Teddle & Tashakkori, 2009:7). In that sense, pragmatists question the usefulness of enquiring after the laws of nature and “truth” and “reality” (Cherryholmes, 1992:16), and “they would simply like to change the subject” (Rorty, 1990:xiv).

4.3 RESEARCH DESIGN

Pragmatists are free to use methods, techniques and procedures to suit their purposes. Because of pragmatism’s focus on “what works,” research data obtained from quantitative, qualitative and/or mixed methods research procedures may be used to the extent that they improve understanding of the research problem (Creswell, 2014:10-11). The quantitative approach followed in this study therefore fits well into a pragmatic worldview. A quasi-experimental as well as a survey design was followed in this study (Creswell, 2014:12); non-standardised tests and surveys were used to gather data.

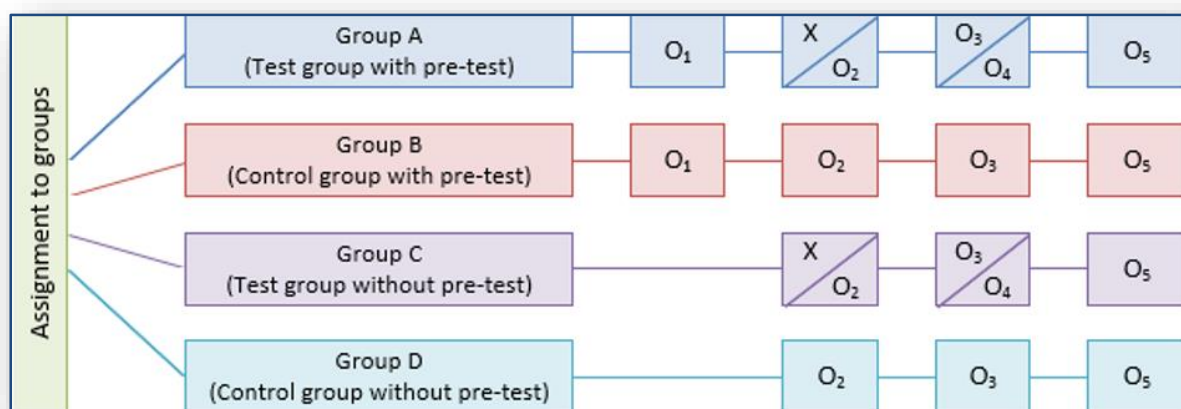
A Solomon four group quasi-experimental design was used to investigate the effect of HMGs on vocabulary acquisition and on reading comprehension, as well as to survey the user experience of

participants (Creswell, 2014:170-174; Solomon, 1949:145). Such a design has two test groups and two control groups. One test group-control group pairing has a pre-test, while the pre-test is absent for the other pairing. This design was indicated, as the research was not only interested in the total differences between groups arising from the administering of the treatment. Also of interest were any differences in vocabulary and reading comprehension between the experimental groups resulting from:

- the treatment in isolation;
- the pre-test;
- incidental learning from the comprehension text, and
- the interaction effect of the pre-test on the treatment.

Solomon (1949:141) points out that the pre-test might in itself have a treatment effect, and might also interact with the actual treatment. He suggests an extended experimental design—embedded in the Solomon four group design—to quantify the various contributors to the overall effect on vocabulary acquisition and reading comprehension.

Using a notation system suggested by Campbell *et al.* (1963:6), this between-group design is illustrated in Figure 4-2.



X : Treatment (HMGs)
 O₁ : Text-specific vocabulary pre-test
 O₂ : Comprehension test
 O₃ : Immediate text-specific vocabulary post-test
 O₄ : User experience survey
 O₅ : Delayed text-specific vocabulary pre-test

Figure 4-2: Quasi-experimental (Pre-test—post-test—delayed post-test) Solomon four non-equivalent group design

4.3.1 Quasi-experimental research

Participants from twelve class groups were assigned to one of the four experimental groups. Three class groups were therefore assigned to each of the four experimental groups. For Group A, a text-specific

vocabulary pre-test (§ 4.4.3.1) was administered (O_1), followed by a comprehension test (O_2) supported by HMGs (X), an immediate text-specific vocabulary post-test (O_3) as well as a user experience survey (O_4) and a delayed text-specific vocabulary post-test (O_5). Group B differed from Group A in the absence of the HMGs during the comprehension test and the absence of the user experience survey. Group C was the same as Group A, but with no pre-test. Group D was the same as Group B, but with no pre-test. The delayed text-specific vocabulary post-test was administered eight weeks after the treatment had been administered. This test was administered to measure longer term gains in vocabulary size due to the treatment. The original intention, following the example of a number of earlier studies (Al Ghafli, 2011:iii; Ben Salem, 2007:ii; Yoshii, 2006:3; Yun, 2011:72), was to administer the delayed post-test two weeks after the treatment. Owing to student and labour unrest (eNews Channel Africa, 2016), complications related to the availability of suitable computer laboratories, and “lecture-free” student test weeks, these tests could, however, only be administered after eight weeks. None of the text-specific vocabulary tests were supported by HMGs.

4.3.1.1 Vocabulary size

The quantitative effect of the HMGs on vocabulary acquisition was determined with reference to the difference in average vocabulary gains between the test group and the control group. To measure the longer term effect on vocabulary size, the text-specific vocabulary test was again administered to participants, this time eight weeks after the treatment had taken place. Again the quantitative effect of the HMGs on vocabulary was determined with reference to the difference in average vocabulary gains between the test group and the control group.

The Solomon four group design resulted in the vocabulary immediate post-tests and delayed post-tests being influenced by four different covariates (treatment, pre-test, incidental learning from comprehension text, and interaction of pre-test on treatment). Pairwise comparisons, both within and between groups, allowed for isolating, in respect of both short and longer term:

- the effect of the treatment on vocabulary;
- the effect of the pre-test on vocabulary;
- the effect of incidental learning from the comprehension text on vocabulary;
- the interaction effect of the pre-test on the treatment, and
- the total effect on vocabulary of administering the vocabulary pre-test and the treatment.

4.3.1.2 Reading comprehension

The same basic design was used to measure the quantitative effect of HMGs on reading comprehension, except that the treatment itself, being in the form of a comprehension test (§ 4.4.3.2), was also the observation. In this case, however, there was no comprehension pre-test or delayed comprehension

post-test for either group, and the effect of HMGs on reading comprehension was determined with reference to the difference in test scores between the various test and control groups.

The Solomon four group design resulted in the comprehension test scores being influenced by three different covariates (treatment, pre-test, and interaction of pre-test on treatment). Pairwise comparisons between groups allowed for isolating:

- the total effect on reading comprehension of administering the vocabulary pre-test and the treatment;
- the effect of the treatment on reading comprehension;
- the effect of the pre-test on reading comprehension, and
- the interaction effect of the pre-test on the treatment.

4.3.2 Survey research

In order to quantitatively describe perceptions of participants regarding the perceived usefulness of the experimental treatment, an online cross-sectional user experience survey (§ 4.4.3.3) was administered to the test group participants—both Groups A and C—concurrent with the immediate vocabulary size post-test (Creswell, 2014:13; Fowler Jr, 2013:1).

Readers' attitudes towards HMGs influence their access frequency of HMGs as well as the amount of attention paid to those HMGs. This in turn increases the likelihood of the glossed word being absorbed into the reader's vocabulary (Davis & Lyman-Hager, 1997:69; Hulstijn *et al.*, 1996:336). It was therefore important to establish the perceptions of participants when evaluating HMGs as a potential contributor towards answering the research question in this study, as these perceptions were likely to influence the frequency with which they interacted with the HMGs.

Underdeveloped ELS of participants might potentially have hampered their ability to express their perceptions by responding to open-ended questions in writing or during interviews or focus groups. The choice for this study of an online survey using rating scale questions allowed participants to respond to questions easily and conveniently. Furthermore, the online platform used to administer the survey automatically recorded participant responses, which improved the reliability of the data used during data analysis.

4.4 RESEARCH METHODS

During this pragmatic study, methods, techniques and procedures were chosen because they met the needs of the research and of the researcher (Creswell, 2014:10-11). The methods followed in the study will be described in the following sections.

4.4.1 Site and participant selection

TUT is a South African university of technology, the largest residential university in the country, with ten learning sites dispersed across four of the country's nine provinces. It draws its approximately 60 000 students from all over the republic, as well as from neighbouring and other foreign countries. The study was conducted from the Directorate: Teaching and Learning with Technology, which is situated at the Pretoria West campus of the university (Tshwane University of Technology, 2012).

Participants in this study were drawn from the approximately 450-500 students distributed over twelve class groups registered for the first time at an HEI in an extended curriculum programme with foundation provision in the Faculty of Engineering and the Built Environment at TUT. The programme is offered at the Pretoria West campus of TUT, which is where the faculty has its seat and where the researcher is stationed. The ages of participants ranged from seventeen to 38, with twenty being the average age. All the official South African languages were represented in the study, with Sepedi, Setswana and Tshivenda accounting for approximately forty percent of participants. Roughly three quarters of the participants were male and one quarter female.

Although all the students registered for this programme were invited to participate in the study, not all the students were present when the questionnaires were administered. A high coverage was however obtained by administering the measuring instruments during an induction programme conducted for these students in the beginning of the academic year and during normally scheduled English Word Power™ (EWP™) computer laboratory sessions.

The data collection instruments were administered electronically in Blackboard Learn™. A consideration when selecting this group of students therefore was the convenience of them already having regular computer time scheduled. Had that not been the case, it would have been necessary to synchronise the various class groups' time-tables with the times during which a limited number of computer laboratories were available.

A further consideration when deciding on this specific group of students was that the reading texts and subject related vocabulary test items used in this study were from the field of Accountancy. Students in Engineering were less likely to encounter Accounting specific texts and vocabulary during the period from the pre-test to the delayed post-test. Under such circumstances, variation in measurements from the pre-test to the immediate and delayed post-test was less likely to be tainted by factors other than those attributable to the intervention. Babbie (2011:179) and Creswell (2014:158) refer to this type of sampling where selection is based on the usefulness of the selection to the study as "purposive" sampling.

Participants were assigned to one of the four experimental groups in the Solomon four group design on the basis of their class groups. As there were twelve class groups, three class groups were assigned to each experimental group. The amount of time required for each experimental group to complete their tests varied with the number of tests each group had to complete. Class groups were assigned to experimental groups to obtain the closest possible match between timetable availability of class groups and length of time required for an experimental group to complete the required tests.

4.4.2 Definition of variables

A variable, also known as a construct, is “a characteristic or attribute of an individual or an organisation that can be measured or observed and that varies among the people or organisation being studied.” They normally vary in attributes, categories or on a continuum of values (Creswell, 2014:52, 250; Mouton, 1996:92). Test scores find their meaning when they can be meaningfully interpreted as indicators of a construct (Chapelle, 1998:33). Trait theorists view constructs as characteristics of test takers. Behaviourists hold that constructs are products of contextual factors, dependent on the environment in which measurements are taken. An Interactionist construct definition will refer to traits of test takers, contextual features influencing the measurement, and the interaction between traits and contexts (Chapelle, 1998:34).

When dealing with the effectiveness of HMGs for vocabulary acquisition, a large number of different types of variables play important roles. The following variables will be scrutinised in this study:

- Presence or absence of HMGs.
- Vocabulary knowledge.
- Reading comprehension.
- Perception of participants of the usefulness of HMGs.

4.4.2.1 Independent treatment variables

Treatment variables are variables which cause, explain or influence effects in the dependent variable(s) (Babbie, 2015:18; Creswell, 2014:52; Mouton, 1996:93-94). The treatment variable manipulated during this study was lexical HMGs. During the experiment HMGs were present for the test groups and absent for the control groups. The elements used in the HMGs varied between:

- English text definitions were provided for 342 words.
- Audio pronunciations were provided for 341 of the 342 words.
- Example sentences were provided for all words.
- Words with similar meaning were provided for 291 of the 342 words.
- What the word does not mean in the specific context were explained for 170 of the 342 words.

- Home language translations were, depending on the language, provided for between 301 and 342 of the 342 words.
- Pictures were provided for 193 of the 342 words.
- Videos and animations were provided for 58 of the 342 words.

4.4.2.2 Dependent variables

Dependent variables are variables where the effect of changes in the independent variables is manifested. Changes in dependent variables are caused by manipulating independent variables (Babbie, 2015:18; Creswell, 2014:52). The dependent variables to be observed in this study, in order of the research question to which they relate and with the related treatment variables in brackets, were:

1. Knowledge of vocabulary used in comprehension test—immediate and delayed post-test;
2. Comprehension of an English reading test;
3. Perception of usefulness of the individual elements embedded in HMGs for vocabulary acquisition and reading comprehension, as well as perception of overall usefulness of HMGs.

4.4.3 Instrumentation and materials

Research data were obtained through collection of data throughout the research project. The instruments and materials used to collect data are discussed in the following sections.

4.4.3.1 Vocabulary size

Vocabulary size can be measured using standardised tests or informal, researcher- or teacher-designed tests, and by receptive vs. productive or expressive techniques. Yun (2011:71) considers multiple choice testing to be “fairly reliable and valid” to measure performance. As there is no single standard for measuring vocabulary, using more than one instrument is critical for sound measuring. The instruments should be well suited to the context within which the measurements take place (National Institute of Child Health and Human Development, 2000:4.16, 14.26). Pearson *et al.* (2007:295) motivate a need for research into computerised adaptive assessment of growth in vocabulary, where the assessment will estimate the level of mastery over all words in a domain of interest, rather than merely benchmarking vocabulary growth against average performance of other students.

Participants’ knowledge of the vocabulary used in the reading comprehension text was measured during a pre-test, an immediate post-test and a delayed post-test conducted eight weeks after the treatment. The number of test items were arrived at by using a sample size calculator available from <http://www.raosoft.com/samplesize.html>, to produce a 95% confidence level with a ten percent margin of error. The calculator rendered a sample size of 76 items, which was rounded to the 75 test items used in the vocabulary test. The sampling rate of 75 test items from the 342 word types in the comprehension

text—219 test items per thousand words—compares favourably with Meara’s “Yes-No” test (Meara, 1992), which uses forty test items and twenty pseudo words per thousand words and Nation’s VST (Nation, 2012:1) which uses ten test items per thousand words. Al Ghafli (2011:60, 140, 149) includes 59 test items from a 902 word text in his custom vocabulary test—a sampling rate of 65 test items per thousand words of text. The high sampling rate employed in the text-specific vocabulary test in this study will take longer to complete than a test with a lower sampling rate, but is likely to produce more accurate results.

The multiple choice text-specific vocabulary test was set using items available from www.vocabulary.com (Thinkmap Inc., 2015). Permission is granted for academic use of such items in the site’s terms of use, provided the material is properly attributed with “Text from Vocabulary.com (<http://www.vocabulary.com>), Copyright ©1998-2015 Thinkmap, Inc. All rights reserved.” Items were obtained by pasting the text used in the comprehension test into a vocabulary list generator. The list generator produced a list of 190 relevant words using a proprietary algorithm. The first 75 words in order of appearance on the list were selected for inclusion in the vocabulary test. A vocabulary list was then created on www.vocabulary.com using the 75 selected words. Test items for the words in the list were generated automatically on the website, and were harvested from the list and included in the vocabulary test.

The text-specific vocabulary test is attached as Annexure C.

4.4.3.2 Reading comprehension test

As context for the intervention, a reading comprehension test was administered to an experimental and control group to measure the effect of the HMGs on reading comprehension. Using the text selected as described in § 4.4.3.4, the researcher and co-supervisor in this study developed a reading comprehension test. While the researcher has considerable knowledge of Accounting, and experience with using educational technology to support English language learning, he has no formal qualifications in English or Applied English Linguistics. The expertise of the co-supervisor was therefore recruited to develop the comprehension test: she has a PhD in English, focussing on Applied Linguistics in ESL assessment.

The comprehension test consisted entirely of multiple choice and true/false questions, as these question types are used regularly in similar studies (Akbulut, 2007:507; Al Ghafli, 2011:66; Ben Salem, 2007:57). There are of course disadvantages to using objective testing: considerable expertise is required to set good questions, and guessing can have a significant but unquantifiable effect on scores, to name a few, but the advantages were considered to outweigh the disadvantages for this study. Of particular importance is the fact that the researcher is not a language expert, which casts doubt on his ability to

score the answers to a test consisting of open-ended items: this doubt was removed by employing objective testing, allowing for reliable scoring. A further consideration carries increased importance where ELS skills of participants are underdeveloped, and receptive language ability is tested. Participants may have good reading comprehension but underdeveloped productive skills in the second language. Requiring of students to write answers might in such a case have prevented them from demonstrating their level of reading comprehension (Al Ghafli, 2011:66; Hughes, 2003:76-78, 143; Lee, 1986:353). Van den Bergh (1990:9-10) has, however, shown that open-ended and multiple choice items measure the same semantic abilities with regard to reading comprehension, with only small differences in measurements between item types. Multiple choice and true/false questions were therefore considered appropriate for use in the comprehension test.

The reading comprehension test is attached as Annexure D.

4.4.3.3 User experience survey

In order to measure participant attitudes towards HMGs, a user experience survey was developed by the researcher and was administered as part of the immediate post-test. The instrument gauged the participants' attitude towards HMGs and the perceived usefulness for participants' of HMGs for reading comprehension and vocabulary acquisition.

Apart from biographical information the questionnaire contained 24 positively worded rating questions and two multiple response questions. For the rating questions a five-point continuous scale—from *Strongly Disagree* to *Strongly Agree*—was used. Overall attitude towards HMGs were measured over eight dimensions, while perceived usefulness of HMGs was measured with reference to how helpful respondents considered each of the eight elements of the HMGs to be for both vocabulary acquisition and reading comprehension. Respondents were also required to indicate the three elements of HMGs perceived to be most helpful for vocabulary acquisition and reading comprehension.

The user experience survey is attached as Annexure E.

4.4.3.4 Text selection

Given the nature of the intervention in this study, and the need for ensuring that the definitions contained in the HMGs are accurate explanations for the context within which the words occur, an elementary Accounting text was considered appropriate. The researcher has considerable background in Accounting, which enabled him to personally ensure the accuracy of gloss definitions used for Accountancy jargon. His background includes an Honours degree in Accounting and completed Accounting Articles of Clerkship. He has also taught in Accountancy and related fields at the former Technikon Witwatersrand.

The textbook used for the course Accounting for Marketers at TUT, namely *Accounting All-in-1* (Cornelius & Weyers, 2011), was selected as source for the texts used in the study. The publishers of the book supplied a copy of the book in Microsoft Word™ format. A selection of paragraphs of text of reasonable length was extracted from across the entire textbook. Selecting text in this way ensured that the contribution by each of the two authors would be represented in the selected text—authors wrote entire chapters on their own, rather than co-authoring all chapters. Selections would then also include sections written with different purposes in mind—language used in introductory paragraphs might, for example, differ from language used during technical discussions.

The paragraphs so selected provided the context for the comprehension test (§ 4.4.3.2) used in the study, the specific words defined in the HMGs (§ 4.4.3.5), and the words tested in the specific vocabulary size test (§ 4.4.3.1).

4.4.3.5 Words selected for glossing

When surveying the literature on HMG effectiveness, it soon becomes clear that the field is riddled with treatment, moderating, mediating and confounding variables, so that it becomes virtually impossible to develop a definitive experiment which will provide answers to all possible questions. The simple act of signalling the availability of an HMG for a word in the text by highlighting it has, for example, been shown to influence access frequency (De Ridder, 2002:135). Variations in access frequency in turn may then influence the effect of gloss use (Beck *et al.*, 2013:5; Chun & Payne, 2004:497-499; Hulstijn *et al.*, 1996:336).

Selecting and signalling only some words for glossing carry the two-pronged risk of influencing findings in respect of participants who needed of HMGs for words which were not chosen for definition, and for users clicking on words not because they do not know the word, but are drawn into clicking on the word due to it having been signalled. Having HMGs for all words in the selected text, and not signalling the availability of HMGs, seemed a prudent approach for limiting the confounding variables not controlled for in the experiment. In this way, users had HMGs available for all unknown words, and they would presumably only access those HMGs they needed, as opposed to being drawn into accessing them through some signalling mechanism.

4.4.3.6 Blackboard Learn™ assessments

The platform chosen for administering the test treatment was Blackboard Learn™, the VLE in use at TUT. It was also used for administering the text-specific pre-, post- and delayed post-tests, the reading comprehension tests and the user experience survey. All participants in the study were registered on the platform, using information obtained from the manager of the academic programme from which the

participants were drawn. Participants logged in to the system using their student numbers as both user ID and password. Logging in using student numbers caused student numbers to be validated against the student numbers held for each student on the system. These numbers were captured programmatically for recording in the gloss access log file (§ 3.2.3), ensuring a high level of data integrity for the student numbers so captured in the log file.

4.4.4 Data collection procedures

The study took place at the Pretoria campus of TUT over two phases. The first phase, spread over two days, was arranged around the four experimental groups, with one session for each experimental group. During this phase, the text-specific vocabulary pre-test, treatment, text-specific vocabulary post-test and user experience survey were administered in three computer laboratories managed by the FEBE. Each laboratory could accommodate one of the three class groups making up each of the four experimental groups. Students were allowed to complete the assessments at their own pace, but with an overall time limit of between two and three hours, depending on the time available on the timetable, which was matched as near as could be with the number and duration of the tests that had to be completed.

The second phase was conducted eight weeks after the first phase. It was arranged around the twelve class groups, with one session for each class group. The sessions were spread over four days due to timetable and computer laboratory availability constraints. During this phase, the delayed text-specific vocabulary post-test was administered in a computer laboratory managed by SDS. This laboratory is the venue normally used by the participants for their EWP™ class periods. The data collection sessions were conducted during the participants' regularly scheduled EWP™ class periods. These weekly periods have a duration of one hour. Students were allowed to complete the assessments at their own pace, but with an overall time limit of approximately one hour per session.

Prior to the commencement of data collection, all participants were assigned, in their class groups, to one of the four experimental groups. A course was set up in Blackboard Learn™ for the sole purpose of collection data from participants. All students registered for the programme were enrolled in the course. The test instruments were created in the course, and made available to students using conditional release, so that each participant only had access to those tests (s)he had to complete. To minimise the risk of participants copying answers from each other, the vocabulary size assessments were set up to randomise questions and distractors for the multiple choice questions: each student received the same questions, but the order of questions and distractors was unique for each participant. Comprehension test questions could not be randomised, as the questions were set with reference to passages of text. Changing the order of questions would disturb the synchronisation of questions with the related text

passages. The glossing system was deployed to the course so that it was only available in the comprehension test for Groups A and C—the two treatment groups.

Results for all the assessments were automatically collected by the VLE's grade book. Once the assessments had been completed, these results were downloaded from the grade book as a Microsoft Excel™ spreadsheet, so that it could be forwarded to the NWU statistical consultation service for further analysis.

4.4.4.1 Phase one

The data collection sessions were administered by student assistants, with the researcher acting as supervisor, roving between the three computer laboratories to resolve any difficulties that arose. The student assistants were senior students from FEBE, experienced in using the VLE. A briefing session was conducted shortly before commencing with data collection. Assistants were briefed on matters considered necessary to enable them to conduct the sessions, such as:

- the purpose of the research project;
- assisting participants to log in to the VLE and accessing the tests;
- briefing participants on their participation in the project, including obtaining informed consent from the students using the online consent form (Annexure F);
- how to access and use the glosses.

At the start of the data collection sessions, participants were seated and requested to access and log in to Blackboard Learn™, using their student numbers as username and password. The assistants then guided participants to access the course home page from where the test instruments were accessible, and then to access the online informed consent form. The assistants explained the study, the data collection process and concomitant commitment required from the participants. The necessity for consent and the voluntary nature of participation was explained, and participants were allowed the opportunity to read through the consent form and to ask clarification questions if necessary. Consenting participants were requested to indicate their consent to participate in the study by selecting a “Yes” radio button. Students who did not wish to participate could select “No” and were allowed to leave the venue. The consenting participants were requested not to share information regarding any of the assessments with participants from another class group, so as not to taint the results collected from those other participants.

The assistants briefly explained the assessments to be administered to the specific group with reference to the research design. The instruments administered during this phase were:

- the text-specific vocabulary pre-test;
- the reading comprehension test;

- the immediate text-specific vocabulary size post-test, and
- the user experience survey.

Assistants then guided participants to access the data collection instruments available to them, and to complete them at their own pace.

For Groups A and C, an additional question was added to the comprehension test. The word “tea” was glossed in this question, and the assistants assisted the participants to access this gloss before commencing with the comprehension test proper. The various elements of the gloss and how to access them were explained to participants. Participants were informed that they could access any HMG as often as they wanted to. Once participants were familiar with accessing and using the gloss, they were allowed to proceed with the comprehension test. The results of this demonstration question were excluded from the research data.

Participants completed the tests available to them, after which they had to exit the course and were allowed to leave the venue.

4.4.4.2 Phase two

These data collection sessions were conducted eight weeks after session 1. During these sessions only the delayed text-specific vocabulary post-test was completed by all participants. The test was to be administered using the same Blackboard Learn™ course used during Phase one. The researcher would personally oversee all these sessions, as they were all conducted in a single venue over twelve sessions, one class group at a time.

At the start of the first data collection sessions, participants were again seated and requested to log in to Blackboard Learn™. However, a network error was encountered, to the extent that hardly any participants were able to log in. The specific session was aborted, and the test was reproduced on paper. For the remaining sessions, data were collected using the paper-based instrument. An additional session was conducted to collect data from the first group.

At the commencement of the sessions, participants were briefly reminded of the nature of the study and the voluntary nature of their participation in it. They were also informed about the specific assessment being administered during the session. Students who did not wish to participate in the study were allowed to leave the venue, or to continue working on the EWP™ course. Consenting participants were requested to complete the delayed text-specific vocabulary post-test at their own pace. Once completed, participants were allowed to leave the venue, or carry on with the EWP™ course.

4.5 DATA ANALYSIS

The experiment performed in this study was designed in consultation with Statistical Consultation Services at the NWU to ensure that appropriate measurements were taken. After data had been collected as described in the previous section, appropriate statistical analyses were performed by Statistical Consultation Services, who also assisted with the interpretation of the analyses. All the histograms depicted in the analysis of the user experience survey were drawn by the researcher using Microsoft Excel™. The data analysis procedures followed are described in the following sections in the context of the research sub-questions.

4.5.1 How will non-linear lexical hypermedia glosses accessible during an English reading comprehension task affect English vocabulary acquisition of readers?

The experimental design used repeated measures, administered to individuals distributed over twelve classgroups based on the study programme for which they enrolled. These classgroups were in turn allocated to one of four experimental groups, based on their availability during specific time slots in an orientation programme time table. It was therefore considered necessary to construct a hierarchical linear model (HLM) to address this sub-question.

Mixed model analysis was conducted using an unstructured covariance matrix. Time and experiment group were treated as fixed measures. The confidence interval for statistical significance was adjusted for multiple tests using the Bonferroni method. To provide a measure of the meaningfulness of the effect of HMGs on text-specific vocabulary test scores and reading comprehension scores, effect sizes were determined and interpreted using guidelines set by Cohen (1988:40) (Table 4-3).

Table 4-3: Effect sizes (Cohen, 1988:40)

<i>d</i>	Effect size
$d = 0.20$	Small
$d = 0.50$	Medium
$d = 0.80$	Large

The significance in gain or attrition in scores from pre- to immediate post-test due to the treatment, and from immediate post-test to delayed post-test due to elapsed time, were determined with reference to variances between the pre-test and the immediate post-test, and between the immediate post-test and the delayed post-test. Specifically, pairwise comparison of group mean differences were used to calculate effect sizes for:

- the effect of the treatment on vocabulary;

- the effect of the pre-test on vocabulary;
- the effect of incidental learning from the comprehension text on vocabulary;
- the interaction effect of the pre-test on the treatment, and
- the total effect on vocabulary of administering the vocabulary pre-test and the treatment.

A line chart was used to present the results of the pre-test, immediate post-test and delayed post-test graphically. Lines were plotted for each of the four groups. Mean test scores of the respective groups for the different tests were used as data points.

4.5.2 How will non-linear lexical hypermedia glosses accessible during an English reading comprehension task affect English reading comprehension of readers?

A one-way post-hoc analysis of variance (ANOVA), using a Tukey test, was conducted to evaluate the effect of the treatment on reading comprehension. Using pairwise comparison of group mean differences, effect sizes were calculated for:

- the total effect on reading comprehension of administering the vocabulary pre-test and the treatment;
- the effect of the treatment on reading comprehension;
- the effect of the pre-test on reading comprehension, and
- the interaction effect of the pre-test on the treatment.

4.5.3 How will readers perceive the usefulness of non-linear contextual lexical HMGs accessible during an English reading comprehension task?

Data were collected using a User Experience Survey. Items required of participants to rate aspects of their experience using HMGs a five-point scale:

1. Strongly Disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly Agree.

Descriptive statistics were drawn from responses for each item, and response distributions were depicted using histograms. The Spearman's rank order correlation coefficient was used to determine the correlation of participants' usefulness ratings with actual scores achieved in the text-specific vocabulary tests and the reading comprehension test.

4.5.3.1 Overview of quantitative analysis of research results

Table 4-4 provides an overview of the research design used in the study. It shows how the research questions were addressed by the design, and what the expected results were.

Table 4-4: Overview of quantitative analysis of research results

Research Question	Variables <i>t = treatment variable(s)</i> <i>d = dependent variable(s)</i>		Data source	Data analysis
1. How will non-linear lexical HMGs accessible during an English reading comprehension task affect English vocabulary acquisition of readers?	t	Lexical HGMs	Text-specific vocabulary size tests	- Descriptive statistics (mean square error, variance per person, HLM p-values, estimated mean scores). - Graph(s): line diagram. - HLM with mixed model analysis, an unstructured covariance matrix, and Bonferroni adjustment of statistical significance. - Practical significance: Cohen's d.
	d	Text-specific vocabulary knowledge		
Expected Results A significant difference in the text-specific vocabulary size pre-test and immediate post-test scores of the participants in the test group when compared to the control group was expected (Yun, 2011:65). It was expected that there would be a significant decrease in text-specific vocabulary scores between the immediate post-test to the delayed post-test (Akbulut, 2007:510; Al Ghafli, 2011:85).				
2. How will non-linear lexical HMGs accessible during an English reading comprehension task affect English reading comprehension of readers?	t	Lexical HGMs	Reading comprehension test	- Descriptive statistics (p-values, estimated mean scores). - Statistical significance: one-way post-hoc analysis of variance (ANOVA), using a Tukey test. - Practical significance: Cohen's d.
	d	Reading comprehension		

Research Question	Variables <i>t</i> = treatment variable(s) <i>d</i> = dependent variable(s)		Data source	Data analysis
Expected results While there is some evidence supporting the effectiveness of HMGs for reading comprehension (Lomicka, 1998:41; Taylor, 2006:310), others find no benefit to reading comprehension (Ariew & Ercetin, 2004:237). Reading comprehension may even be hindered (Sakar & Ercetin, 2005:28). While a clear positive relationship between vocabulary size and reading comprehension exists (Carroll <i>et al.</i> , 2011:2; National Institute of Child Health and Human Development, 2000:4.1-3), the type of HMG as well as constraints in working memory capacity may play a significant mediating role (Plass <i>et al.</i> , 2003:221, 227). For these reasons, no clear expectation existed regarding the effect of HMGs on reading comprehension in this study.				
3. How will readers perceive the usefulness of non-linear contextual lexical HMGs accessible during an English reading comprehension task?	t	Lexical HMGs	User experience survey	- Descriptive statistics (range, mean score, standard deviation, mode) - Graphs: Histograms - Spearman’s rank order correlation coefficient, used to determine correlation between usefulness ratings and actual test scores.
	d	Perception of usefulness for vocabulary acquisition and reading comprehension, and of overall usefulness.		
Expected results There is some evidence that the order of preference for HMGs is images, then video, then audio and then text (Sakar & Ercetin, 2005:36). In the current study however, multimedia elements were accessed through the click of a button, while the text definition was available by default. An L2 translation for the specific words was also available when selecting a language from a drop-down list. Where a first language translation is available, L2 translation should rate highly among readers (Davis & Lyman-Hager, 1997:58). Audio pronunciations would not be rated as useful for comprehension, but would provide information regarding the proper pronunciation of words (Ariew & Ercetin, 2004:253). Readers were expected to perceive lexical HMGs as useful, making reading enjoyable and easier to understand. This positive attitude was not expected to correlate with actual test scores (Ariew & Ercetin, 2004:253; Sakar & Ercetin, 2005:28).				

4.6 VALIDITY OF INTERPRETATION AND TRANSFER

Coe (2012a:41) poses an important question to be considered in the conduct of research, namely: “How can we establish the strength and applicability about interpretations and inferences?” This section provides an overview of the traditional and a more modern approach to addressing the issue. The unified validity framework and an approach to crafting a test validation argument are introduced. It concludes by building an argument about the strength and applicability of the interpretations made and inferences drawn by this study. It builds this argument using an approach suggested by Coe (2012a:43, 48) as being more appropriate to interpretations of data gathered during research and transfer of those interpretations to varying settings.

4.6.1 Early validity theory

In the traditional view, the accuracy of test measurements is evaluated with reference to their validity and reliability. Validity is viewed as a property of a test and deals with the content of tests and the techniques employed in them. A measurement is seen as valid when “it measures accurately what it is intended to measure” (Hughes, 2003:2-3, 26). Reliability deals with the interaction between the test taker and the features of the test, as well as with the scoring of the test. Measurements are seen as reliable when they measure consistently—the same test taker would get a similar score if the test was taken at a different occasion (Hughes, 2003:3-4).

4.6.1.1 Validity

Four categories of validity are identified, namely content validity, construct validity, predictive validity and concurrent validity. The latter two categories may be grouped together as criterion-oriented validity procedures (Creswell, 2014:160; Cronbach & Meehl, 1955:281-282; Fulcher & Davidson, 2007:4; Messick, 1987:8).

Content validity concerns itself with whether the items included in the test adequately represents the whole spectrum of the construct being measured. Answering test items should also require the type of responses from respondents that would normally be required from the population represented by respondents when interacting with that construct (Fulcher & Davidson, 2007:6; Hughes, 2003:26).

A test has construct validity if the construct being measured is representative of only that underlying ability or trait which it represents and nothing else. Construct validity has particular importance when the underlying ability or trait cannot be measured directly (Hughes, 2003:22-27).

Criterion-oriented validity is concerned with relating the results of a specific test to a criterion which it purports to measure or predict (Cohen *et al.*, 2011:189). Concurrent criterion validity is established by

administering the test instrument and the criterion reference instrument at the same time and then determining the level of agreement between the two tests. A high level of agreement between the test scores and the criterion reference scores would indicate that the test instrument provides valid concurrent criterion scores, and vice versa. Predictive criterion validity refers to the degree with which the results of an assessment can be used to predict a future criterion, such as year-end exam results, of the test taker (Fulcher & Davidson, 2007:5-6; Hughes, 2003:27).

Internal threats inherent to the research design may cause the researcher to conclude that observed effects were caused by experimental treatments, when in fact they were caused by something else. The researcher could then reach invalid conclusions about the test population from the results of an experiment. External threats to validity in turn may cause the researcher to generalise the conclusions drawn from experimental results to populations and settings beyond the applicability of the study. The researcher should take steps to minimise or eliminate internal and external threats to validity (Creswell, 2014:174, 176).

While not a scientific measure of validity, face validity is also of importance. Not concerned so much with what is measured, face validity is concerned with what the test *seems* to measure. A test which does not seem to measure that which it purports to measure, might not be found acceptable by test takers and those administering tests, making face invalidity something to be avoided (Hughes, 2003:33; Messick, 1987:13).

4.6.1.2 Reliability

Reliability deals with the interaction between the test taker and the features of the test, as well as with the scoring of the test. Measurements are seen as reliable when they measure consistently—the same test taker would get a similar score if the test was taken at a different occasion (Hughes, 2003:3-4).

Although reliability is viewed as a consideration somewhat separate from validity, there is still some interplay. Gains in reliability may often come at the cost of less validity and vice versa, as there is always some interplay between reliability and validity (Coe, 2012a:41; Hattingh, 2009:35; Hughes, 2003:50). While reliability in itself does not guarantee validity, a test score must be reliable to be valid (Bachman, 1990:160; Coe, 2012a:41).

4.6.2 Modern validity theory and a unified validity framework

In time, as a consequence of all these types of evidence of validity contributing to finding the meaning of test scores, they have all come to be viewed as different dimensions of construct-related evidence for validity (Messick, 1987:16). Even reliability of measurement is no longer viewed as an issue somewhat

separate from validity. Instead, it is examined under scoring validity as another of the dimensions of construct related evidence for validity (Coe, 2012a:41; Hattingh, 2009:48, 78).

An important contribution to this modern validity discourse is Messick's unified validity framework (Messick, 1987:17). In terms of this framework validity is no longer a property of a measurement. Instead, the various traditional categories of evidence of validity contributes and interacts with evidence from other sources in building an argument to justify the inferences we draw from test scores about a construct as well as the actions we take as a result of those inferences (Coe, 2012a:41; Fulcher & Davidson, 2007:12-13, 159; Hattingh, 2009:48) (Table 4-5).

Table 4-5: Facets of validity (Adapted from Messick, 1987:17)

	TEST INTERPRETATION	TEST USE
EVIDENTIAL BASIS	Construct validity	Construct validity + Relevance/utility
CONSEQUENTIAL BASIS	Construct validity + Value implications	Construct validity + Social consequences

Construct validity underlies all the facets of validity. It is the evidential basis for the validity of test interpretation. It is also the evidential basis for the validity of test use, strengthened by adding evidence about the relevance of the test to the context and purpose for which it was designed and in which the measurement was taken. The consequential basis for the validity of test interpretation is construct validity bolstered by an appraisal of the role researcher values play in the understanding and framing of the construct and in interpreting measurements. Finally, the consequential basis for the validity of test use is the validity of the construct as well as evidence obtained from the evaluation of the potential and actual social consequences of administering the test and of implementing the decisions taken as a result of conclusions drawn from the scores. Possible consequences of alternative interpretations of test results should also be considered here. While the discourse around validity in testing is ongoing, the unified validity framework has become the dominant framework for evaluating validity in psychological, educational and language testing (Fulcher & Davidson, 2007:14; Messick, 1987:17-19, 98).

4.6.3 The argument for validity of interpretation and transfer claims

Messick's unified validity framework (Messick, 1987:17) is useful as a conceptual framework, but provides little guidance about the actual process to be followed for validating score interpretations or uses of

those interpretations (Kane, 2012:7). Coe (2012a:41, 43) proposes a two-pronged argument-based approach to answering the question: “How can we establish the strength and applicability of claims about interpretations and inferences?” He identifies two types of claims made by researchers: i) interpretation claims and ii) transfer claims. His approach builds arguments in support of these claims and addresses threats to them.

4.6.3.1 Constructs

Three constructs are measured in this study, namely i) vocabulary acquisition, ii) reading comprehension, and iii) perceived usefulness. The sense in which these constructs should be understood for purposes of this study is described below.

- **Vocabulary acquisition**

Vocabulary knowledge is a multi-dimensional construct. Qian (2002:514-516) organises these dimensions into vocabulary breadth (or size), vocabulary depth, lexicon organisation and automaticity of receptive or productive knowledge. Most studies of vocabulary investigate breadth—how many words are known, and depth—how well words are known. Laufer *et al.* (2004:206-207) differentiate between four levels of word knowledge: i) active recall, ii) passive recall, iii) active recognition, and iv) passive recognition. In this study, passive recognition of words whose full meaning are moderately well known is investigated. Passive recognition requires the ability to retrieve the meaning of a word from a list of options.

- **Reading comprehension**

Reading comprehension is taken to mean the extent to which the reader (the decoder) is able to successfully interpret the textual clues inserted into a text by the author (the encoder) about the meaning the author is attempting to convey to the reader through the medium of the text. Reading comprehension requires interaction between the decoder and the encoder participating in the discourse. The extent of reading comprehension can't be fully measured, as it is influenced by the clarity of the clues contained in the text, the knowledge of the reader and the reader's purpose for reading the text (Widdowson, 1984:169).

- **Perceived usefulness**

Davis (1989a) defines perceived usefulness as “the degree to which a person believes that using a particular system would enhance his or her job performance.” He adds that users will perceive a system as highly useful when they believe a positive use-performance relationship to exist. Perceived usefulness in this study has to be understood in the context of perceived usefulness of the individual HMG elements for aiding vocabulary acquisition and reading comprehension. The perceived overall

usefulness of HMGs accessible during a reading task is also included in this understanding. Perceived usefulness is viewed from the perspective of the participants in this study. This participant perspective makes it difficult to provide a precise clarification of the meaning of the construct, as the meaning will vary between participants, depending on their individual understanding of the construct.

4.6.3.2 Interpretation claims

In the quantitative tradition, interpretation claims can be descriptive or interpretive. Descriptive claims—“this is what happened”—are represented by quantitative data such as are captured in test scores. Interpretive claims—“this is what it means”—require analysing and synthesising the recorded data in order to interpret its meaning. Validation of research in this tradition requires making arguments to justify interpretation claims made about the data (Coe, 2012a:43). Arguments supporting the interpretation claims made by this study are presented next by answering a number of questions as suggested by Coe (2012a:43-48).

- **“Is the interpretation plausible?”**

Content validity. Normally it would be possible to strengthen content validity claims by using standardised instruments. This study was, however, seated within a specific subject-related context, and required measurement instruments suited to the context of the study. Consequently, custom instruments were developed for the study. The text paragraphs from which test items for the text-specific vocabulary tests and the comprehension test were drawn, were selected from across the entire *Accounting All-in-1* (Cornelius & Weyers, 2011). This is the textbook used for the course Accounting for Marketers⁴ at TUT. Test items were then developed to be representative of all the selected text paragraphs. The user experience survey required participants exposed to the HMGs to rate every HMG element for its usefulness, both for vocabulary acquisition and reading comprehension.

Construct validity and face validity. As mentioned in § 4.4.3.4 the researcher has considerable expertise in Accountancy. To support the claim for construct and face validity of the text-specific vocabulary tests and the comprehension test, these were developed by the researcher together with an Applied Linguist with experience in language test development. The text-specific vocabulary tests were populated with items available from www.vocabulary.com (Thinkmap Inc., 2015). Only a few limited modifications to such test items were considered necessary, such as removing typographical

⁴ For a justification of the choice to use participants from FEBE in the study when the subject matter for the measurement instruments is Accounting, refer to the explanation in § 4.4.1

clues to correct answers. The tests were then reviewed for face validity by another subject matter expert (SME) in the field of Accountancy. A small pilot study using these two instruments were conducted with students from NWU to identify any potential problems with the instruments. The user experience survey was reviewed for face validity by a representative from the statistical consultation service of the NWU, who provided valuable input towards the improvement of the instrument.

Non-written question types were used for all three instruments. Multiple choice tests items were used in the text-specific vocabulary size test and the reading comprehension test. A combination of rating scale and multiple selection items was used for the user experience survey. These test item types are all available in the Blackboard Learn™ VLS choice of objective testing, meaning that responses could be recorded and scored accurately and reliably. For the text-specific vocabulary tests, item presentation was randomised, largely removing the risk of students copying from each other. Furthermore, by eliminating the need for responding to questions in written form, learners would be less disadvantaged by inadequate productive English language skills.

All statistical analyses were performed by the Statistical Consultation Service of the NWU, improving the accuracy with which supporting data were analysed. Histograms were however quite easy to draw using Microsoft Excel™, and were consequently drawn by the researcher.

- **“Is the interpretation corroborated by other evidence?”**

No specific evidence of criterion-related validity is presented to corroborate the interpretation claims made in this study. The instruments were not administered alongside validated reference instruments, nor were the instruments developed to predict a criterion to be measured at a later date. It is, however, not unusual for researcher designed measurement instruments to be used in studies of this nature (Al Ghafli, 2011:66-68 ; Ben Salem, 2007:59-60), and some assurance is taken from using the same type of measurement instruments as were used elsewhere (Al Ghafli, 2011:67-69; Davis & Lyman-Hager, 1997:61). Of necessity, more reliance has to be placed on construct validity in the absence of evidence for criterion related validity.

- **“Is the interpretation based on an adequate range of supporting data, methods and contexts?”**

Construct under-representation often accompanies the use of computer-based test-item types, such as were used in this study. Using items scored by computer trades convenience off against construct representativeness. The study addresses this dilemma by narrowing the definition of constructs measured and then ensuring that the instruments used are of a type deemed appropriate to measure the constructs as defined. Guidance was taken from previous studies, such as mentioned in the

previous paragraph, in deciding on the supporting data to collect, and the type of instruments to use to collect that data. Coe (2012a:46) cautions that measurements of the same trait, using different measures, correlate only moderately well. Reliance was therefore placed on SMEs from the Applied Linguistics and Accountancy fields to ensure that the data which were collected adequately support the interpretation claims made.

- **“Could the interpretation have been influenced by other spurious or inappropriate features of the research process?”**

As was mentioned in § 2.9, HMG studies are riddled with the complex interactions between research variables, confounding variables and variable research designs compromising their discriminant validity. Interpretation claims made in this study could have been influenced by construct irrelevant variables. In the absence of criterion-related validity measures, discriminant validity becomes difficult to establish. Test bias in this study could have been caused by:

Time. There was an interlude of eight weeks between the administration of the treatment and the delayed text-specific vocabulary post-test. Initially a two-week period was planned, but student protests, availability of a computer laboratory and a “lecture-free” test week interfered, so that the post-test was only administered eight weeks after the treatment. Many construct irrelevant variables could have arisen during that period.

Time constraints and the time of day. During both data collection phases, sessions were scheduled to suit participants’ academic time tables. For some students, the time allowed was not sufficient to complete their assessments. Furthermore, groups were tested at different times during the day—some groups early in the morning, others late in the afternoon. It may well be that results could have been influenced by the time of day at which test were taken. Some students taking the tests early in the morning while still well rested may well have performed better than others rushing to complete the tests in order to avoid missing their transport home at the end of the day.

Participants. The participants in the study were chosen from FEBE, while the text and vocabulary used in the vocabulary size and reading comprehension measurements were Accountancy-related. This was an attempt to limit participants’ exposure to Accounting terminology, more so than had the participants been selected from a course in Accountancy. The choice of a four-group design, however, allows for the effect size of certain variables to be quantified and isolated from the treatment effect.

Medium. Unforeseen technical problems prevented the computer based administration of the comprehension test to some participants from the treatment group. The delayed text-specific

vocabulary post-test could also not be taken on computer. Consequently, paper-based answer sheets were used during these tests.

Responses were then captured manually. Data verification was done by capturing data twice, comparing the two datasets and reconciling conflicts. Errors could, however, have been caused by students coding their answers incorrectly, or by decoding answers incorrectly during data capturing.

Participants might have been more familiar with paper-based testing than computer-based testing. A difference in familiarity with the test administration medium could have had influences on test scores. Such differences could also have influenced inter-group comparability, and comparability between versions of the same test administered at different times.

Test behaviours. Administering data collection instruments could have been viewed as “tests” by participants. This may have triggered test anxiety in some participants, while other participants may have felt pressure to complete the “test” as quickly as possible. For multiple choice questions, some participants may have guessed answers rather than leaving questions unanswered when unsure about the answers. Some participants may have rated elements based on what they believed the “proper” answer to be, rather than rating elements honestly. These conditions could have influenced participant responses and scores. To minimise such influence, care was taken during the pre-test briefings to explain carefully that these were not academic tests. Participants were reassured that there would be no negative impact to academic performance or otherwise, and that questions should be answered in a manner reflective of their knowledge, understanding and opinions.

Computer literacy. Being unfamiliar with computers may have caused anxiety. Even in the absence of anxiety, low levels of mouse skills may for example have had an influence on participants’ use of HMGs, and on scores achieved during electronic tests.

Language. The background to this study highlights the typically low level of ELS among students at TUT. In the worst cases, the level of participants’ skills could perhaps have hindered their ability to understand verbal and written explanations and instructions. It could also have influenced their ability to understand the explanations contained in the HMGs, which could in turn have influenced their HMG access behaviour.

- **“Does the interpretation, or its likely uses, lead to any desirable or undesirable consequences?”**

In evaluating the consequential validity of interpretations, the consequences and uses of those interpretations—referred to as backwash—must be considered. Evidence must be provided that the interpretations are relevant and useful for their intended purposes, and that using interpretations for

such purposes is justified (Coe, 2012a:45, 48). There are a number of possible consequences emanating from this study, such as:

- It has already resulted in the development of a functional tool which can be deployed in Blackboard Learn™. This study has identified certain shortcomings of the tool, some of which have already been addressed, others which will be addressed in future.
- It is an introductory study for this researcher. Similar studies have not been performed in an identical context. This study will allow the researcher to develop a greater understanding of the practical issues involved in doing research about HMGs. It will identify contextual uniquenesses affecting the optimal implementation of HMGs in this context.

Washback⁵ emanating from this research project will not cause harm to participants. The test results are kept confidential by the researcher and are not shared with subject facilitators other than through the research report. The study was not devised as a component of a specific academic programme and results are reported anonymously. Academic achievement of individual participants can therefore not be affected. Ultimately, recommendations from this study might lead to students benefiting from richer learning experiences, leading to improved achievement of learning outcomes through improved vocabulary and comprehension. At worst, the time and money spent developing the tool and the database of HMG terms may be rendered wasteful, should findings be adverse or undue reliance be placed on invalid findings. Care has been taken, as evidenced by §§ 2.7, 2.8 and 2.9, to build a strong argument in justification of developing the HMG system and embarking on this research project.

4.6.3.3 Transfer claims

Transfer claims are claims about the applicability of research findings to contexts other than the context in which the research was conducted. Generalisation claims are substantiated by arguments for the representativeness of samples. Transferability claims are substantiated by arguments that findings could theoretically be applicable to different settings. Arguments are also presented about the extent to which certain features are unique to the actual research setting. Care should be taken not to under- or overestimate the contextual uniqueness of a particular research study. Underestimation could result in making undue generalisations while overestimation could unnecessarily restrict the applicability of findings to different settings. (Coe, 2012a:43, 48).

⁵ Washback, also referred to as backwash, can be defined as “the effect of testing on teaching and learning” (Hughes, 2003:2). Washback—which can be beneficial or harmful—occurs wherever a change in teaching and learning is in direct anticipation or consequence of a test being introduced in that context (Fulcher & Davidson, 2007:221).

Next, to assist in the formulation or refining of a working hypothesis, information is provided about matters affecting reliability and external validity, using the ordering introduced by Coe (2012a:49-52):

- **Reliability: Transfer across occasions**

No evidence of test-retest reliability can be provided for the data collection instruments administered during this study. The comprehension test and the user experience survey were only administered once. The text-specific vocabulary pre- and immediate post-tests were separated by the reading comprehension test. The immediate post-test results could in all likelihood have been influenced by the HMGs available to the test group during the comprehension test. Even the control group could have benefited from vocabulary learnt incidentally during the comprehension test. The immediate text-specific vocabulary post-test and delayed vocabulary post-test were separated by eight weeks, during which time new words could have been learnt. These conditions are not considered suitable to allow comparison of different administrations of the same test for the purpose of establishing test-retest reliability. No claims are consequently made about the ability of the text-specific vocabulary test to measure text-specific vocabulary consistently over time.

- **Reliability: Transfer across instruments**

The way in which tests were administered does not support claims that participants would perform similarly on similar tests containing different questions. The comprehension test and user experience survey were only administered once. The identical test was used for each of the three administrations of the text-specific vocabulary test. Parallel forms reliability and internal consistency therefore had to be established by determining Cronbach's alpha.

Text-specific vocabulary test. This test was developed to measure knowledge of vocabulary immediately before, immediately after and eight weeks after the HMG treatment. It consisted of 75 multiple-choice items, and was found to be reliable ($\alpha = 0.762$).

Comprehension test. This test, developed to measure the reading comprehension of both the test and control groups, consisted of 32 multiple-choice and true/false question. The test was found to be only marginally reliable ($\alpha = 0.563$).

User experience survey. This test, consisting of six sections, was developed to determine the perceived usefulness of HMGs to participants from the test groups. Three sections contained rating scale questions:

- The perceived usefulness for vocabulary acquisition section consisted of eight questions, and was found to be highly reliable ($\alpha = 0.858$).
- The perceived usefulness for reading comprehension section consisted of eight questions, and was found to be highly reliable ($\alpha = 0.877$).

- The perceived overall usefulness section consisted of eight questions, and was found to be highly reliable ($\alpha = 0.877$).

- **Reliability: Transfer across observers**

Objective testing, administered and scored electronically, was chosen for use in this study, as it would improve the reliability of test scores by eliminating errors or inconsistencies encountered where human judgement is applied (Hughes, 2003:23). Test items in measurement instruments were either objectively marked multiple choice items, or rating scale questions. Scoring such items required no judgement to be applied by scorers. Scoring was done by computer and by the researcher personally in the case of the comprehension test for the treatment groups and the delayed text-specific vocabulary post-test for all experimental groups. Scores can therefore reasonably be accepted as entirely transferable across observers.

- **External validity: Transfer across participants**

Generalisability in this study across participants is hampered because participant selection was done by purposive sampling. For practical reasons, allocation of participants to experimental groups was on the basis of their class group membership. While an element of randomness might be inherent in such an allocation, an element of bias is as likely. Furthermore, as was argued in § 4.6.3.2, there were many construct irrelevant variables present during this study. For these reasons, generalisability of interpretations made will be difficult to justify, and is not sought far beyond assisting the formulation of a working hypothesis by the reader(s) of this report. Only the reader is sufficiently familiar with his or her own context to formulate such a working hypothesis through naturalistic generalisation⁶ for application in his or her own context (Coe, 2012a:49; Cronbach, 1975:124-125; Lincoln & Guba, 1985:41, 122-124). For the researcher in this study, the interpretations made in this study serve to clarify and augment his own naturalistic generalisation, which in turn has influenced and will influence his own working hypothesis of “what works” for hypermedia glossing.

- **External validity: Transfer across contexts**

Again, no claim is made about the generalisability of interpretation across contexts. The tests were developed with the specific context of this study in mind. While some guidance for classroom based test construction might be gained from the process followed in this study, the instruments themselves were not intended for use in different contexts.

⁶ Naturalistic generalisation is the assimilation of new knowledge, experiences and understandings into existing ones, the existing ones having been constructed through surveying of and reflecting on previous research (Coe, 2012a:49).

4.7 ETHICAL ASPECTS OF THE RESEARCH

Four main principles guided ethical research practice. These are autonomy, beneficence, non-harmfulness and justice (North West University, 2010:48). Slack (2007:4) includes non-harmfulness (“Do no harm”) in her discussion of “beneficence.” A number of applicable ethical issues addressed prior to commencing the research project, at the commencement of the project, while collecting, analysing and storing data and when disseminating research findings (Creswell, 2014:92-101) are discussed next under the relevant principle.

4.7.1 Respect for autonomy

The individual’s right to make autonomous choices and act upon those choices without undue influence should be encouraged and respected (Slack, 2007:4). At the commencement of data collection, the research participants were fully informed of the researcher’s identity and sponsoring institution, the scope and purpose of the research, and the level of their involvement in the study. The benefits and risks to themselves emanating from the research were carefully explained. Informed consent to participate voluntarily was obtained from participants (Annexure F).

As the researcher has no relationship with the participants beyond the process of data collection, the risk of undue pressure being exerted on participants—e.g. by promising bonus marks counting towards participants’ course grades—to participate or to respond to data collection instruments in a specific manner, was minimised. Participants had the right to withdraw from the project at any stage without fear of consequence.

Even though the researcher had no intention of creating the impression of a power position over participants, participants may well still have perceived such a power relationship to exist. To avoid such a situation, great care was taken in creating an atmosphere of friendliness and openness during data collection. Using objective testing may have reduced their anxiety about their responses being misinterpreted, as might have been the case had interviews or open-ended questions been used to collect data.

4.7.2 Respect for beneficence

Researchers should act to increase the benefits and limit the risks concomitant to the research project to research participants individually and to society as a whole, and to ensure a fair balance between benefit and risk (Slack, 2007:5). Beneficence starts with selecting a research problem that will benefit not only the researcher, but also others. The research problem in this study was identified from research done about the extent of weak ELS at TUT (Dockrat, 2007), and the possible effect thereof on the academic achievement of students. It is envisaged that research findings may contribute to improving ELS of

students, leading to improved opportunity for meaningful interchange between student and learning content and, consequently, the possibility of improved academic achievement. Research results have been and will be disseminated to a wide audience of facilitators of learning, who might benefit from being able to apply these results in their own contexts.

Before any data were collected, ethical clearance for the project was obtained from the Research Ethics Committee of NWU (Ethical approval reference number: NWU-00061-13-A2) (Annexure G). Such clearance is necessary where human individuals are involved to ensure that research is conducted in a way that no harm is caused to participants in the research projects. Written permission to undertake the study using students enrolled in a FEEB foundation programme was obtained from the dean of the faculty and the foundation programme manager. The latter request for permission was considered an important measure to prevent serious disruption to the academic programme of the participants.

When deciding on the focus of the study, care was taken not to select a topic where the outcome of the study could have a material impact on the welfare of the researcher, as such an interest could well have influenced the objectivity of research results. The only foreseeable benefits accruing to the researcher from the research will be a further qualification which will assure security of tenure at his place of work and will be accompanied by a cash incentive in terms of the employer's policy. None of these benefits are dependent on the nature of the research findings.

Participation in the study by the participants did not result in any material benefit to them, other than a possible improvement in language skills. Their participation or non-participation was entirely voluntary, and the nature of their participation could not be influenced by the researcher other than as a result of the treatment administered during the research. The research was not related in any way to their formal curricula, and could therefore not affect their academic grades in any way.

Authorship of the research report is acknowledged in terms of normal protocol for doctoral theses. The researcher was the sole author of the report, which was conducted under supervision of a research supervisor and a co-supervisor, who are acknowledged as such on the title page of the research report. Any other significant contributions to the study are also be acknowledged in the front matter to the report.

While the need for comparative analyses of results required participants to be individually distinguishable, the results were treated confidentially. Participants were unknown to the researcher, and their names and surnames were only used when preparing data for analysis, as a means of ensuring comparisons were made against the correct comparative data. Thereafter, names and surnames were removed from the database, and analyses were performed using student numbers. Access to the test

environment was limited to researcher, the participants and indirectly to the university's Blackboard Learn™ system administrator. Once research data had been extracted from the test environment, test result data were removed from the test environment. Access to research data was limited to the researcher and the statistician consulted on the analysis of data. Such data were referenced by student number only, so that individual students were not identifiable. Institutional policy regarding the storage of collected data has been, and will be, strictly adhered to. During the period for which data have to be stored, they will be stored on a password protected computer to which only the researcher has access. Once the period for which data have to be stored has expired, data will be deleted from the hard drive of the computer.

Roediger and Marsh (2005:1158) warn that some harm may come to participants when a multiple choice test instrument is administered. This may be especially pertinent where a multiple choice test is repeatedly administered, such as in the pre-test, post-test, delayed post-test regimen used in this study. Where corrective feedback is not provided and during an earlier test participants guessed an incorrect answer, they may come to believe that they have selected the correct option. During the next encounter, the same option may again be selected due to the mistaken belief that it is the correct option. In this way, faulty learning may occur and may even be reinforced during the later test. Apart from the user experience survey, all the test instruments used in this study are in the form of multiple choice tests. While it would have tainted results of the specific vocabulary size test if corrective feedback had been given after the pre- and post-test, feedback was provided programmatically after the delayed post-test, as well as after the reading comprehension test. In so doing, the risk that faulty learning might occur was minimised as far as possible. Even if faulty learning did occur, the potential detrimental impact was further reduced by the learning being mainly seated in the domain of Accounting, while the participants were mainly FEBE students.

4.7.3 Respect for justice

The benefits and risks adhering to the research project should be distributed equitably between all the parties to the research (Slack, 2007:6). While it is true that both the researcher (by way of improved qualifications, subsidised research outputs and job related remuneration) and TUT (by way of improved ability to serve internal and external clients) will benefit from the research, research participants should also benefit from improved ELS, given that at TUT the academic language, and hence the vehicle for the conveying of meaning, is English. Improved ELS of participants should lead to improved opportunity for future meaningful interchange between student and learning content and, consequently, the possibility of improved academic achievement (Taylor, 2006:315).

Rewarding participants for participation brings the risk of undue influence. Rewarding all participants similarly might also place a heavy financial burden on the researcher, possibly preventing the research from being undertaken at all. While it is in scant measure, the researcher made a point of expressing his sincere appreciation to participants for the time and effort they invested in the data collection process. They did receive the benefit of immediate feedback on their text-specific vocabulary size before, immediately after and eight weeks after the treatment, as well as feedback about their reading comprehension which was made available at the conclusion of the data collection.

Where a test group and a control group are used during a research project, the risk exists that the test group may receive an unfair advantage or disadvantage above the control group, arising from their participation in the treatment. It would however hinder the outcome of the research, were the control group to be granted access to the treatment prior to data collection being completed. To negate the risk of unfairness inherent in the control group not receiving the same treatment as the test group, access to treatment materials were extended to control group participants once all data collection instruments had been administered. In so doing, participants from the control group would have an opportunity similar to participants from the test group to explore a text supported by HMGs.

4.8 CHAPTER SUMMARY

In this chapter, the research design was described in terms of three interrelated components, namely the researcher's philosophical worldview, a research design suitable to that worldview, and the specific research methods used when conducting the research. The approach to analysing and interpreting data collected in the study was explained, and an argument was advanced for the justification of inferences drawn from test scores and for the actions taken as a result of those inferences. Ethical aspects of the research, guided by the principles of respect for autonomy, beneficence and justice, were discussed.

CHAPTER 5

RESULTS

5.1 INTRODUCTION

This study examined the usefulness of non-linear lexical HMGs for supporting English Second Language vocabulary acquisition and reading comprehension of readers when the HMGs are integrated into electronic reading materials. The effect of HMGs on short- and long-term vocabulary acquisition and reading comprehension was explored. The perceived usefulness of HMGs for vocabulary acquisition and reading comprehension, as well as their overall usefulness, was also investigated.

Data were collected using a different administrations of the same text-specific vocabulary test, a comprehension test and a user experience survey. The treatment was administered using a Solomon four-group design (Creswell, 2014:170-174; Solomon, 1949:145). The test groups took the reading comprehension test supported by HMGs, while the control group took the test unsupported by HMGs. One test group and one control group did a text-specific vocabulary pre-test, while the other two groups did not. All four groups did an immediate and a delayed text-specific vocabulary post-test. The two treatment groups also completed the user experience survey.

This chapter reports on the demographic composition of participants and presents analyses and visual representations of the data collected in response to each of the sub-questions.

5.2 DEMOGRAPHIC COMPOSITION OF PARTICIPANTS

Participants in the study were drawn from students registered for the first time in a foundation programme in FEBE at TUT. A total of 415 valid cases completed the all the relevant assessments assigned to their group in terms of the Solomon four group design used in this study (refer § 4.3).

Participants in the study were allocated to one of four experimental groups on the basis of their class groups. There were two test groups—A and C, and two control groups—B and D. Groups A and B did a text-specific vocabulary pre-test, while Groups B and D did not. All four groups then did a comprehension test, an immediate text-specific vocabulary post-test and a delayed text-specific vocabulary post-test. For the test groups, the comprehension test was supported by HMGs, while the control groups did the comprehension test without HMG support.

Group A, consisting of 108 participants, made up 50.9% of the test group participants, and 26.0% of all participants. Group C, consisting of 104 participants, made up 49.1% of the test group participants, and 25.1% of all participants. Group B, consisting of 90 participants, made up 44.3% of the control group participants, and 21.7% of all participants. Group D, consisting of 113 participants, made up 55.7% of the control group participants, and 27.2% of all participants (Table 5-1).

Table 5-1: Test group-Control group cross tabulation

Test group-Control group cross tabulation			
Group	Frequencies		
	Test group	Control group	Total
A	108 (50.9% of test group)		108 (26.0% of total)
B		90 (44.3% of control group)	90 (21.7% of total)
C	104 (49.1% of test group)		104 (25.1% of total)
D		113 (55.7% of control group)	113 (27.2% of total)
Total	212 (% of total)	203 (% of total)	415

The age of participants varied between seventeen and 38 with both the average and median age being twenty. The mode of participants' age was nineteen, with 149 (32.53%) participants being nineteen years old (Table 5-2).

Table 5-2: Age distribution of participants

Attribute: Age	Frequency (n = 415)	Percentage
17	2	0.48%
18	29	6.99%
19	137	33.01%
20	105	25.30%
21	65	15.66%
22	35	8.43%
23	17	4.10%
24	9	2.17%
25	8	1.93%
> 25	8	1.93%
Average = 20	Median = 20	Mode = 19

Participants were predominantly male. Of the participants, 347 (75.76%) were male, approximately three times more than the 111 females, who made up 24.24% of participants (Table 5-3).

Table 5-3: Gender distribution of participants

Attribute: Gender	Frequency (n = 415)	Percentage
Male	309	74.46%
Female	106	25.54%

All eleven official languages were represented in the study. The best represented language grouping was Sepedi, with 122 participants (26.64%) indicating it as their home language. Sixty participants (13.10%) were Setswana speaking, and 44 (9.61%) were Tsonga speaking. The least spoken South African language was Xhosa: Fourteen participants (3.06) indicated it as their home language. Three participants had a home language other than one of the officially recognised South African home languages (Table 5-4).

Table 5-4: Home language distribution of participants

Attribute: Home language	Frequency (n = 415)	Percentage
Sepedi	113	27.97%
Setswana	51	12.62%
Tshivenda	41	10.15%
isiZulu	38	9.41%
Xitsonga	37	9.16%
siSwati	33	8.17%
Sesotho	23	5.69%
English	20	4.95%
isiNdebele	19	4.70%
Afrikaans	14	3.47%
isiXhosa	14	3.47%
Other	1	0.25%
Missing values	11	

One participant was removed from the dataset entirely. The participant was allocated to experimental Group B, but completed the tests assigned to experimental Group C. Rather than risk contamination of data, the relevant results were excluded entirely from the analyses.

A further nine students recorded scores of zero in a test—seven in the immediate text-specific vocabulary post-test and two in the delayed text-specific vocabulary post-test. Upon investigation it was found that these students submitted tests without attempting a single answer. These submissions were not considered as useful for inclusion in the scores for the two tests, and were therefore removed from the scores of the particular tests. Scores achieved by these nine participants for other tests were however still included in the analyses of those tests.

An initial analysis of data revealed unexpected results. Investigation of the data sets revealed 23 participants who started the immediate text-specific vocabulary post-test, but did not complete it due to time constraints. Allowing for the incomplete answer sets when estimating means went a long way to render results which were more aligned to expected parameters. The results of the data analysis are first reported with incomplete answer sets included, and thereafter with them excluded from the data sets.

5.3 RESULTS OF DATA ANALYSIS

In order to contribute to addressing the main research question, the study poses three sub-questions. To attend to sub-question one, data were collected using a text-specific vocabulary test. This test was administered directly before, directly after and eight weeks after the HMG treatment as per the research design (§ 4.3). The data required to attend to sub-question two were collected by administering a reading comprehension test. The HMG treatment was imbedded in the comprehension test for the test groups, while the control groups were not supported by HMGs. A user experience survey was administered to participants from the treatment groups. Data collected through this survey were used to attend to sub-question three. This section presents the results and an analysis of the data collected in respect of each sub-question.

5.3.1 Results: How will non-linear lexical HMGs accessible during an English reading comprehension task affect English vocabulary acquisition of readers?

The Solomon four group research design used in this study required construction of a hierarchical linear model (HLM) to address this sub-question. Mixed model analysis was conducted in an unstructured covariance matrix. Time and experiment group were treated as fixed measures. As multiple tests were done, a Bonferroni adjustment of the confidence interval was made. Effect sizes were determined to provide a measure of the practical significance of the effect of HMGs on text-specific vocabulary test scores. The results of the initial analysis are shown in Table 5-5.

Table 5-5: Fixed effects, co-variance parameters and estimated means

Mean Square Error	Variance per person	HLM p-values		
		Group	Time	Group * Time
71.4934	77.201468	0.009	0.112	0.000
Experimental group		Time		Means
A	Pre-test		82.240	
	Immediate post-test		82.296	
	Delayed post-test		82.771	
B	Pre-test		84.766	
	Immediate post-test		85.557	
	Delayed post-test		83.471	
C	Pre-test		n.a.	
	Immediate post-test		83.223	
	Delayed post-test		83.645	
D	Pre-test		n.a.	
	Immediate post-test		75.644	
	Delayed post-test		83.268	

Estimated means were recalculated after adjusting for the incomplete answer sets of the participants who did not complete the immediate post-test. The results of the second analysis are shown in Table 5-6.

Table 5-6: Fixed effects, co-variance parameters and estimated means (Incompletes excluded)

Mean Square Error	Variance per person	HLM p-values		
		Group	Time	Group * Time
28.5444	68.3863	0.621	0.229	0.578
Experimental group		Time		Means
A	Pre-test		82.159	
	Immediate post-test		83.269	
	Delayed post-test		82.950	
B	Pre-test		84.011	
	Immediate post-test		85.417	
	Delayed post-test		83.687	
C	Pre-test		n.a.	
	Immediate post-test		83.012	
	Delayed post-test		83.726	
D	Pre-test		n.a.	
	Immediate post-test		83.534	
	Delayed post-test		82.701	

The following sections elaborate on the results contained in these two tables. Distinction is made in terms of effect size between immediate post-test results and delayed post-test results. A graphical representation of the change in estimated mean vocabulary scores over time for the four groups is also shown.

5.3.1.1 Between-group effect of HMGs on vocabulary acquisition

Variances between the pre-test and the immediate post-test, indicating the significance of gain or decline in estimated mean scores across the four experimental groups, were determined. Specifically, pairwise comparison of differences in group mean scores for the immediate post-test were used to calculate effect sizes for:

- the effect of the treatment on vocabulary;
- the effect of the pre-test on vocabulary;
- the effect of incidental learning from the comprehension text on vocabulary;
- the interaction effect of the pre-test on the treatment; and
- the total effect on vocabulary of administering the vocabulary pre-test and the treatment.

The immediate effect of the treatment on vocabulary. Group D did not complete the pre-test and did not receive the treatment. Group C, however, did receive the treatment. The difference in estimated mean scores between these two groups can therefore be attributed to the effect of the treatment. In the initial analysis, a pairwise comparison showed a practically visible improvement in mean vocabulary scores (medium effect size = 0.62). The second analysis, with incompletes removed, showed no practically significant effect on mean vocabulary scores (small effect size = 0.05).

The delayed effect of the treatment on vocabulary. In the initial analysis, a pairwise comparison showed no practically significant effect of the treatment on estimated mean vocabulary scores (small effect size = 0.03). The second analysis, with incompletes removed, also showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.10).

The immediate effect of the pre-test on vocabulary. Group B completed the pre-test, but Group D did not. The difference in estimated mean scores between Group B and Group D can therefore be attributed to the effect of the pre-test. In the initial analysis, a pairwise comparison of Group B with Group D showed a practically significant improvement in estimated mean vocabulary scores (large effect size = 0.81). The second analysis, with incompletes removed, showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.19).

The delayed effect of the pre-test on vocabulary. In the initial analysis, a pairwise comparison showed no practically significant effect of the pre-test on estimated mean vocabulary scores (small effect size = 0.02). The second analysis, with incompletes removed, also showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.10).

The immediate effect of incidental learning from the comprehension text on vocabulary. This effect size relied on the assumption that Group D, had they done the pre-test, would have achieved a score similar to the average of the scores achieved by Groups A and B (Solomon, 1949:147). Group D's immediate post-test score was not affected by the pre-test or the treatment. Any difference between the estimated pre-score and the immediate post-test score for Group D can then be attributed to incidental learning from the comprehension text. In the initial analysis, this comparison showed a practically visible deterioration in estimated mean vocabulary scores (medium effect size = 0.64). The second analysis, with incompletes removed, showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.05).

The delayed effect of incidental learning from the comprehension text on vocabulary. In the initial analysis, this comparison showed a practically visible effect of incidental learning on estimated mean

vocabulary scores (medium effect size = 0.63). The second analysis, with incompletes removed, showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.08).

The immediate interaction effect of the pre-test on the treatment. Both Groups A and B completed the pre-test, but Group A also received the treatment. Differences in mean scores between Group A and B can be attributed to the effect of the treatment combined with the interaction effect of the pre-test on the treatment. As the effect of the pre-test had already been determined, the interaction effect could be isolated by removing the pre-test effect from the difference in mean scores between Group A and Group B. In the initial analysis, the interaction was associated with a significant deterioration in estimated mean vocabulary scores (large effect size = 0.89). The second analysis, with incompletes removed, showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.17).

The delayed interaction effect of the pre-test on the treatment. In the initial analysis, the interaction of the pre-test on the treatment showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.09). The second analysis, with incompletes removed, also showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.18).

The immediate total effect on vocabulary of administering the vocabulary pre-test and the treatment. Finally, the total effect can be calculated as the combined effect of all the previously calculated component effects. In the initial analysis, the total effect of administering the pre-test and the treatment was not associated with a significant effect on estimated mean vocabulary scores (small effect size = 0.10). The second analysis, with incompletes removed, also showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.02).

The delayed total effect on vocabulary of administering the vocabulary pre-test and the treatment. In the initial analysis, there was a positive, practically visible total effect of administering the pre-test and the treatment on estimated mean vocabulary scores (medium effect size = 0.58). The second analysis, with incompletes removed, showed no practically significant effect on estimated mean vocabulary scores (small effect size = 0.06).

5.3.1.2 Within-group (“Time”) effect of HMGs on vocabulary acquisition

Variances between the immediate post-test and the delayed post-test, indicating the significance of gain or decline in estimated mean scores over the period of the study, were determined. A line chart was then used to present the results of the pre-test, immediate post-test and delayed post-test graphically. Lines were plotted for each of the four groups. Mean test scores of the respective groups (Table 5-7) were used as data points.

Table 5-7: Within group ("Time") effect of treatment on vocabulary acquisition

Experimental group	Vocabulary scores						
	Pre-test mean (P)	Difference	Effect size	Immediate post-test mean (IP)	Difference	Effect size	Delayed post-test mean (DP)
A	82.240	0.056	0.00	82.296	0.475	0.04	82.771
B	84.766	0.791	0.06	85.557	(2.086)	0.17	83.471
C	n.a.			83.223	0.423	0.03	83.645
D	n.a.			75.644	7.624	0.63	83.268

- **Group A (Pre-test and treatment)**

There was a very small improvement in actual estimated mean vocabulary score from the pre-test to the immediate post-test. The improvement was not practically significant (small effect size = 0.00). The improvement in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test was also small, and not practically significant (small effect size = 0.04).

- **Group B (Pre-test, no treatment)**

There was a small improvement—larger than for Group A—in actual estimated mean vocabulary score from the pre-test to the immediate post-test. The improvement was not practically significant (small effect size = 0.06). The actual estimated mean vocabulary score decreased slightly between the immediate post-test and the delayed post-test. The decrease was not practically significant (small effect size = 0.17).

- **Group C (No pre-test, with treatment)**

Participants from Group C did not complete the pre-test. The improvement in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test was small, and not practically significant (small effect size = 0.03).

- **Group D (No pre-test and no treatment)**

Participants from Group D did not complete the pre-test. The improvement in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test was practically visible (medium effect size = 0.63).

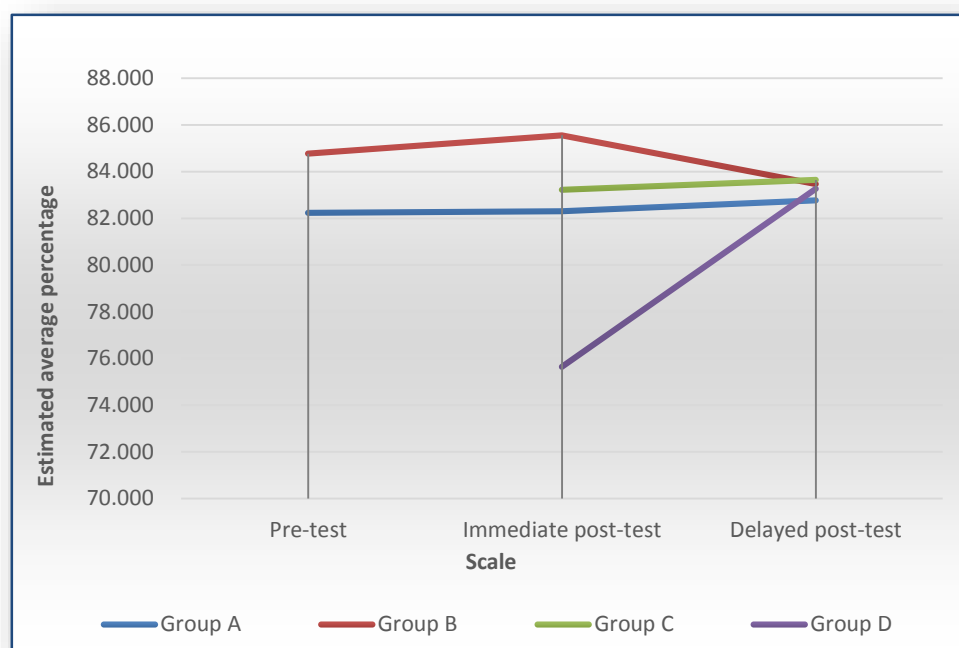


Figure 5-1: Within group ("Time") effect of treatment on vocabulary acquisition

Figure 5-1 shows no significant differences in estimated mean vocabulary scores for three of the four experimental groups over the three administrations. For one group—Group D—there was a practically visible improvement in the estimated mean vocabulary score from the immediate post-test to the delayed post-test.

Incomplete assessments were then excluded from the data-sets, and the analysis was repeated (Table 5-8).

Table 5-8: Within group ("Time") effect of treatment on vocabulary acquisition (Incompletes excluded)

Experimental group	Vocabulary scores						
	Pre-test mean (P)	Difference	Effect size	Immediate post-test mean (IP)	Difference	Effect size	Delayed post-test mean (DP)
A	82.159	1.110	0.11	83.269	(0.319)	0.03	82.950
B	84.011	1.406	0.14	85.417	(1.730)	0.18	83.687
C	n.a.			83.012	0.714	0.07	83.726
D	n.a.			83.534	(0.832)	0.08	82.701

- **Group A (Pre-test and treatment)**

There was an improvement in actual estimated mean vocabulary score from the pre-test to the immediate post-test. The improvement was not practically significant (small effect size = 0.11).

There was a decrease in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test, which was not practically significant (small effect size = 0.03).

- **Group B (Pre-test, no treatment)**

There was a small improvement—larger than for Group A—in actual estimated mean vocabulary score from the pre-test to the immediate post-test. The improvement was not practically significant (small effect size = 0.14). The actual estimated mean vocabulary score decreased slightly between the immediate post-test and the delayed post-test. The decrease was not practically significant (small effect size = 0.18).

- **Group C (No pre-test, with treatment)**

Participants from Group C did not complete the pre-test. The improvement in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test was small, and not practically significant (small effect size = 0.07).

- **Group D (No pre-test and no treatment)**

Participants from Group D did not complete the pre-test. The decrease in actual estimated mean vocabulary score between the immediate post-test and the delayed post-test was small, and not practically significant (small effect size = 0.08).

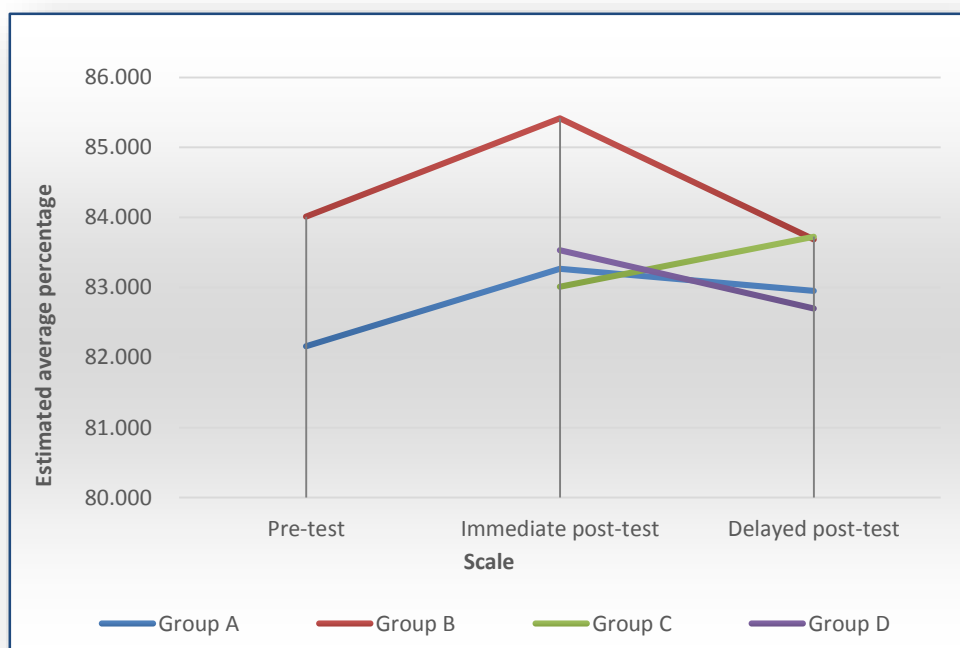


Figure 5-2: Within group (“Time”) effect of treatment on vocabulary acquisition (Incompletes excluded)

Figure 5-2 shows no significant differences in estimated mean vocabulary scores for all four of the experimental groups over the three administrations. For one group—Group C—there was a small though practically insignificant improvement in the estimated mean vocabulary score from the immediate post-test to the delayed post-test. The pattern for Group A and B seems to be an improvement from pre-test to immediate post-test, then a decrease to the delayed post-test, with the delayed post-test score still being higher than the pre-test score. All of these changes are however of no practical significance.

5.3.2 Results: How will non-linear lexical HMGs accessible during an English reading comprehension task affect English reading comprehension of readers?

To evaluate the effect of the treatment on reading comprehension, a one-way post-hoc analysis of variance (ANOVA) was conducted using a Tukey post-hoc test. The results of analysis of variance and the pairwise comparisons are shown in Table 5-9.

Table 5-9: Effect of treatment on reading comprehension

ANOVA						
	Sum of Squares	df	Mean Square	F	Sig.	
Between groups	621.774	3	207.258	1.524	0.208	
Within groups	41 218.108	303	136.033			
Total	41 839.882	306				
Pairwise comparisons						
Effect	Group	Mean	Group	Mean	Difference	Effect size
Total effect	Group A	44.521	Group D	46.120	(1.598)	0.14
Effect of pre-test	Group B	48.719	Group D	46.120	2.600	0.20
Treatment effect	Group C	46.835	Group D	46.120	0.715	0.06
Interaction effect	Total effect – treatment effect – effect of pre-test				(4.914)	0.37

Pairwise comparison of differences in group mean reading comprehension scores were performed.

Between-group variances revealed the significance of gain or decline in estimated mean scores across the four experimental groups. Effect sizes were calculated for:

- the total effect on reading comprehension of administering the vocabulary pre-test and the treatment;
- the effect of the pre-test on reading comprehension;
- the effect of the treatment on reading comprehension; and
- the interaction effect of the pre-test on the treatment.

While both the treatment and the pre-test had an effect on the average score, the ANOVA yielded no statistically significant effect of the treatment on reading comprehension [$F(3,303) = 1.524, p = 0.208$].

The total effect on reading comprehension of administering the vocabulary pre-test and the treatment.

Participants from Group A completed the pre-test and received the treatment. Group D, however, did not complete the pre-test and did not receive the treatment. The difference in estimated mean scores between these two groups therefore reflects the entire effect on reading comprehension of the pre-test, the treatment and any interaction effect of the pre-test on the treatment. A pairwise comparison showed no practically significant change in mean reading comprehension scores (small effect size = 0.14).

The effect of the pre-test on reading comprehension⁷. Group B completed the pre-test only, while Group D did not complete any tests. The difference in estimated mean scores between Group B and Group D can therefore be attributed to the effect of the pre-test. A comparison of Group B with Group D showed no practically significant change in estimated mean reading comprehension scores (small effect size = 0.20).

The effect of the treatment on reading comprehension. Group C received the treatment with no pre-test, while Group D received neither the pre-test nor the treatment. The difference in estimated mean scores between Group B and Group D can therefore be attributed to the effect of the treatment. A pairwise comparison showed no practically significant change in mean reading comprehension scores (small effect size = 0.06).

The interaction effect of the pre-test on the treatment. Both Groups A and B completed the pre-test, but Group A also received the treatment. Differences in mean scores between Groups A and B can be attributed to the effect of the treatment combined with the interaction effect of the pre-test on the treatment. As the effect of the pre-test had already been determined, the interaction effect could be isolated by removing the pre-test effect from the difference in mean scores between Groups A and B. The interaction was not associated with a practically significant change in estimated mean vocabulary scores (small effect size = 0.37).

Other pairwise comparisons were possible, but those comparisons produced combined effects. For example, comparing Group A with Group B would render the combined effect of the interaction of the

⁷ While there was no reading comprehension pre-test, there was a text-specific vocabulary pre-test. A strong correlation between vocabulary and reading comprehension exists (Carroll *et al.*, 2011:2; National Institute of Child Health and Human Development, 2000:4.1-3). An improvement in vocabulary attributed to the effect of the vocabulary pre-test, might then also contribute to an improvement in reading comprehension.

pre-test and the treatment on reading comprehension. The reported comparisons, however, isolated the effects of interest to this study.

5.3.3 Results: How will readers perceive the usefulness of non-linear contextual lexical HMGs accessible during an English reading comprehension task?

This question investigated the usefulness of non-linear lexical HMGs accessible during an English reading comprehension task in terms of three aspects:

- usefulness for vocabulary acquisition,
- usefulness for reading comprehension, and
- overall usefulness.

Of the 212 participants in the treatment groups (Table 5-1), only 150 were able to complete the user experience survey within the allotted time. The results of data collected by administering the survey are reported in the following sections. Results in respect of usefulness for vocabulary acquisition and for reading comprehension are combined, where after overall usefulness is shown. The relationship between overall perceived usefulness and actual test scores is also reported.

5.3.3.1 Results: Usefulness of non-linear lexical HMGs for vocabulary acquisition and reading comprehension

English definitions. The results for “The English definitions in the pop-up dictionary helped me learn new words” and “The English definitions in the pop-up dictionary helped me understand what I read” are shown in Table 5-10 and Figure 5-3.

Table 5-10: Perceived usefulness of English definitions for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 4.17	SD = ± 0.764	$\bar{x}$ = 4.29	SD = ± 0.759
Mode	“Agree” (n = 77)		“Agree” (n = 68)	
	n	%	n	%
Strongly Agree (5)	50	34.2%	63	42.9%
Agree (4)	77	52.7%	68	46.3%
Neutral (3)	14	9.6%	12	8.2%
Disagree (2)	4	2.7%	3	2.0%
Strongly Disagree (1)	1	0.7%	1	0.7%
Missing values	4		3	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1				

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 127; % = 87.0) perceived the *English definitions* in the HMGs as useful for vocabulary acquisition. Fourteen participants were indecisive (% = 9.6), while five participants (% = 3.4) did not perceive the *English definitions* as useful. The most frequently occurring rating was *Agree* (Mode = 77; % = 52.7), followed by *Strongly Agree* (n = 50; % = 34.2) with *Strongly Disagree* (n = 1; % = 0.7%) occurring least often. The average rating was 4.17 (SD = ± 0.764).

Usefulness for comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 131; % = 89.1) perceived the *English definitions* in the HMGs as useful for reading comprehension. Twelve participants were indecisive (% = 8.2), while four participants (% = 2.7) did not perceive the *English definitions* as useful. The most frequently occurring rating was *Agree* (Mode = 68; % = 46.3%), followed by *Strongly Agree* (n = 63; % = 42.9) with *Strongly Disagree* (n = 1; % = 0.7%) occurring least often. The average rating was 4.29 (SD = ± 0.759).

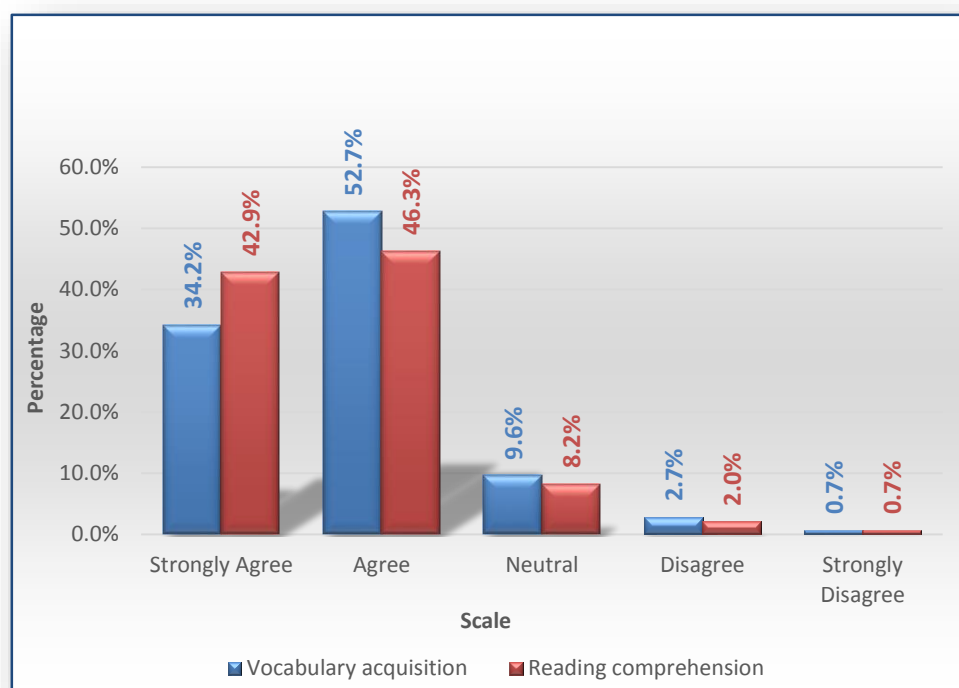


Figure 5-3: Perceived usefulness of English definitions for vocabulary acquisition and reading comprehension

Example sentences. The results for “The example sentences in the pop-up dictionary helped me learn new words” and “The example sentences in the pop-up dictionary helped me understand what I read” are shown in Table 5-11 and Figure 5-4.

Table 5-11: Perceived usefulness of example sentences for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 2
Mean ¹	$\bar{x} = 3.97$	SD = ± 0.919	$\bar{x} = 4.16$	SD = ± 0.720
Mode	“Agree” (n = 71)		“Agree” (n = 71)	
	n	%	n	%
Strongly Agree (5)	41	28.5%	47	33.3%
Agree (4)	71	49.3%	71	50.4%
Neutral (3)	21	14.6%	21	14.9%
Disagree (2)	8	5.6%	2	1.4%
Strongly Disagree (1)	3	2.1%	0	0.0%
Missing values	6		9	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants ($n = 112$; $\% = 77.8$) perceived the *Example sentences* in the HMGs as useful for vocabulary acquisition. Twenty-one participants were indecisive ($\% = 14.6$), while eleven participants ($\% = 7.6$) did not perceive the *Example sentences* as useful. The most frequently occurring rating was *Agree* (Mode = 71; $\% = 49.3$), followed by *Strongly Agree* ($n = 41$; $\% = 28.5$) with *Strongly Disagree* ($n = 3$; $\% = 2.1$) occurring least often. The average rating was 3.97 ($SD = \pm 0.919$).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants ($n = 118$; $\% = 83.7$) perceived the *Example sentences* in the HMGs as useful for reading comprehension. Twenty-one participants were indecisive ($\% = 14.9$), while two participants ($\% = 1.4$) did not perceive the *Example sentences* as useful. The most frequently occurring rating was *Agree* (Mode = 71; $\% = 50.4$), followed by *Strongly Agree* ($n = 47$; $\% = 33.3$) with *Disagree* ($n = 2$; $\% = 1.4$) occurring least often. The average rating was 4.16 ($SD = \pm 0.720$).

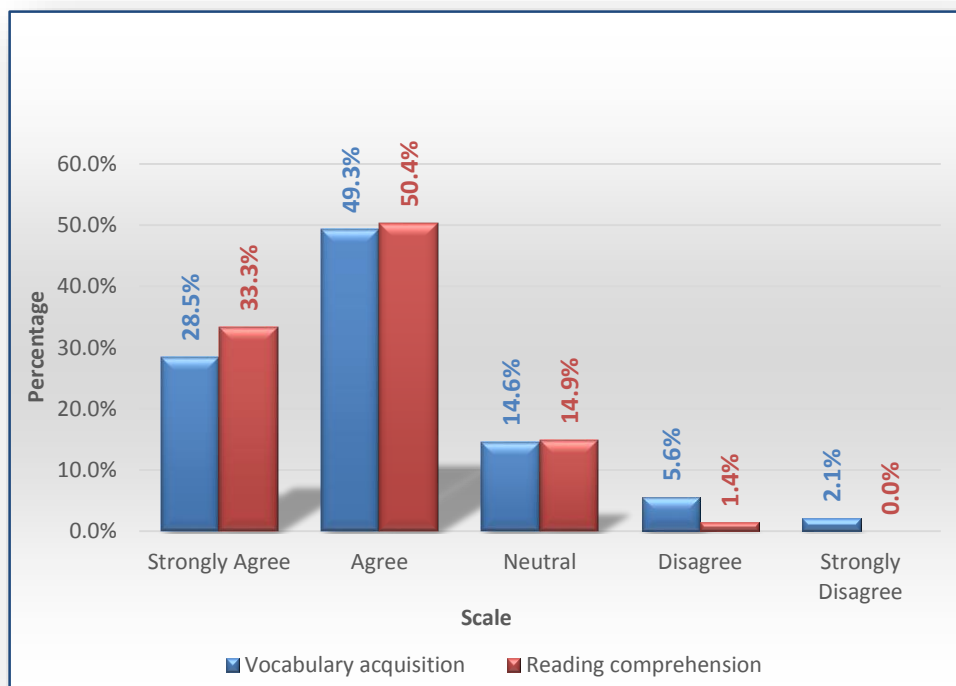


Figure 5-4: Perceived usefulness of example sentences for vocabulary acquisition and reading comprehension

Words with similar meaning. The results for “The words with similar meaning in the pop-up dictionary helped me learn new words” and “The words with similar meaning in the pop-up dictionary helped me understand what I read” are shown in Table 5-12 and Figure 5-5.

Table 5-12: Perceived usefulness of words with similar meaning for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 4.11	SD = ± 0.805	$\bar{x}$ = 4.11	SD = ± 0.761
Mode	“Agree” (n = 74)		“Agree” (n = 73)	
	n	%	n	%
Strongly Agree (5)	45	31.7%	45	31.5%
Agree (4)	74	52.1%	73	51.0%
Neutral (3)	18	12.7%	22	15.4%
Disagree (2)	3	2.1%	2	1.4%
Strongly Disagree (1)	2	1.4%	1	0.7%
Missing values	8		7	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1				

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 119; % = 83.8) perceived the *Words with similar meaning* in the HMGs as useful for vocabulary acquisition. Eighteen participants were indecisive (% = 12.7), while five participants (% = 3.5) did not perceive the *Words with similar meaning* as useful. The most frequently occurring rating was *Agree* (Mode = 74; % = 52.1), followed by *Strongly Agree* (n = 45; % = 31.7) with *Strongly Disagree* (n = 2; % = 1.4%) occurring least often. The average rating was 4.11 (SD = ± 0.805).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 118; % = 82.5) perceived the *Words with similar meaning* in HMGs as useful for reading comprehension. Twenty-two participants were indecisive (% = 15.4), while three participants (% = 2.1) did not perceive the *Words with similar meaning* as useful. The most frequently occurring rating was *Agree* (Mode = 73; % = 51.0%), followed by *Strongly Agree* (n = 45; % = 31.5) with *Strongly Disagree* (n = 1; % = 0.7%) occurring least often. The average rating was 4.11 (SD = ± 0.761).

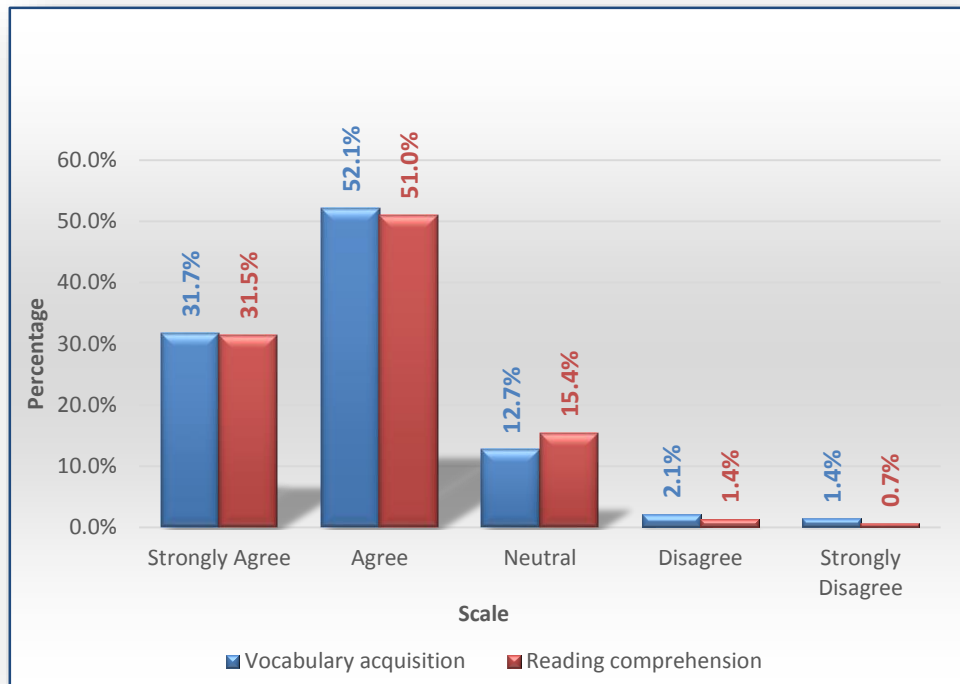


Figure 5-5: Perceived usefulness of words with similar meaning for vocabulary acquisition and reading comprehension

Explanations of what the word does NOT mean. The results for “The explanations of what the word does NOT mean in this sentence in the pop-up dictionary helped me learn new words” and “The explanations of what the word does NOT mean in this sentence in the pop-up dictionary helped me understand what I read” are shown in Table 5-13 and Figure 5-6.

Table 5-13: Perceived usefulness of explanations of what the word does NOT mean for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 3.68	SD = ± 0.939	$\bar{x}$ = 3.66	SD = ± 0.943
Mode	“Agree” (n = 66)		“Agree” (n = 61)	
	n	%	n	%
Strongly Agree (5)	23	16.8%	24	17.5%
Agree (4)	66	48.2%	61	44.5%
Neutral (3)	32	23.4%	35	25.5%
Disagree (2)	13	9.5%	15	10.9%
Strongly Disagree (1)	3	2.2%	2	1.5%
Missing values	13		13	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1				

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 89; % = 65.0) perceived the *Explanations of what the word does NOT mean in this sentence* in the HMGs as useful for vocabulary acquisition. Thirty-two participants were indecisive (% = 23.4), while sixteen participants (% = 11.7) did not perceive the *Explanations of what the word does NOT mean in this sentence* as useful. The most frequently occurring rating was *Agree* (Mode = 66; % = 48.2), followed by *Neutral* (n = 32; % = 23.4) with *Strongly Disagree* (n = 3; % = 2.2%) occurring least often. The average rating was 3.68 (SD = ± 0.939).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 85; % = 62.0) perceived the *Explanations of what the word does NOT mean in this sentence* in the HMGs as useful for reading comprehension. Thirty-five participants were indecisive (% = 25.5), while seventeen participants (% = 12.4) did not perceive the *Explanations of what the word does NOT mean in this sentence* as useful. The most frequently occurring rating was *Agree* (Mode = 61; % = 44.5%), followed by *Neutral* (n = 35; % = 25.5) with *Strongly Disagree* (n = 2; % = 1.5%) occurring least often. The average rating was 3.66 (SD = ± 0.943).

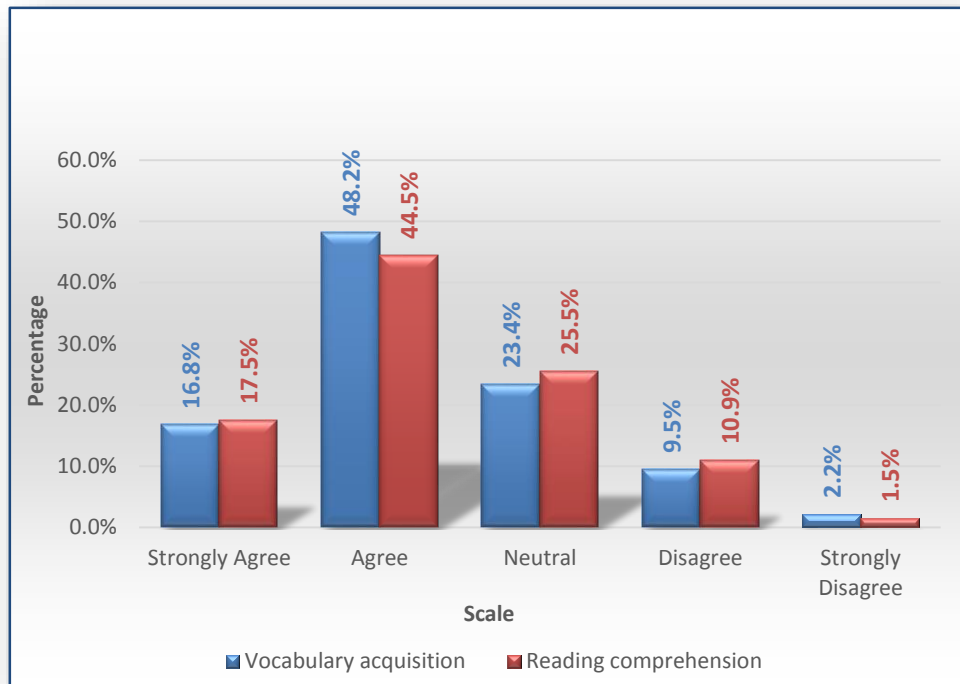


Figure 5-6: Perceived usefulness of explanations of what the word does not mean in the specific context for vocabulary acquisition and reading comprehension

Home language translations. The results for “The home language translations in the pop-up dictionary helped me learn new words” and “The home language translations in the pop-up dictionary helped me understand what I read” are shown in Table 5-14 and Figure 5-7.

Table 5-14: Perceived usefulness of home language translations for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x} = 3.80$	SD = ± 1.117	$\bar{x} = 3.78$	SD = ± 1.051
Mode	“Agree” (n = 49)		“Agree” (n = 46)	
	n	%	n	%
Strongly Agree (5)	40	30.3%	37	28.5%
Agree (4)	49	37.1%	46	35.4%
Neutral (3)	26	19.7%	32	24.6%
Disagree (2)	10	7.6%	11	8.5%
Strongly Disagree (1)	7	5.3%	4	3.1%
Missing values	18		20	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants ($n = 89$; $\% = 67.4$) perceived the *Home language translations* in the HMGs as useful for vocabulary acquisition. Twenty-six participants were indecisive ($\% = 19.7$), while seventeen participants ($\% = 12.9$) did not perceive the *Home language translations* as useful. The most frequently occurring rating was *Agree* (Mode = 49; $\% = 37.1$), followed by *Strongly Agree* ($n = 40$; $\% = 30.3$) with *Strongly Disagree* ($n = 7$; $\% = 5.3$) occurring least often. The average rating was 3.80 ($SD = \pm 1.117$).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants ($n = 83$; $\% = 63.8$) perceived the *Home language translations* in the HMGs as useful for reading comprehension. Thirty-two participants were indecisive ($\% = 24.6$), while fifteen participants ($\% = 11.5$) did not perceive the *Home language translations* as useful. The most frequently occurring rating was *Agree* (Mode = 46; $\% = 35.4$), followed by *Strongly Agree* ($n = 37$; $\% = 28.5$) with *Strongly Disagree* ($n = 4$; $\% = 3.1$) occurring least often. The average rating was 3.78 ($SD = \pm 1.051$).

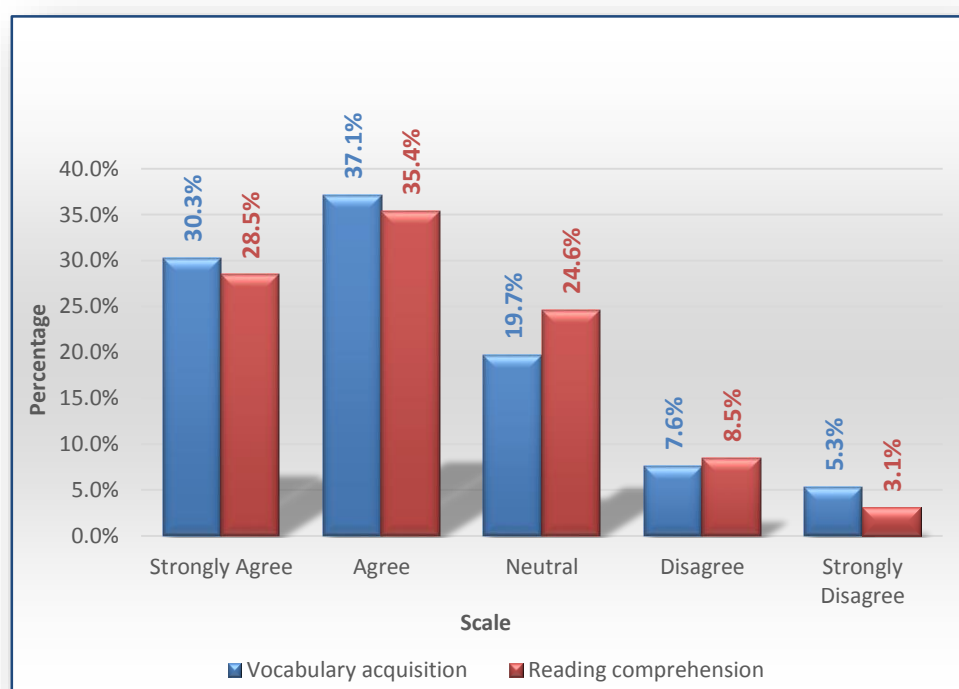


Figure 5-7: Perceived usefulness of home language translations for vocabulary acquisition and reading comprehension

Audio pronunciations. The results for “The audio pronunciations in the pop-up dictionary helped me learn new words” and “The audio pronunciations in the pop-up dictionary helped me understand what I read” are shown in Table 5-15 and Figure 5-8.

Table 5-15: Perceived usefulness of audio pronunciations for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 3.65	SD = ± 0.994	$\bar{x}$ = 3.56	SD = ± 1.001
Mode	“Agree” (n = 44)		“Neutral” (n = 46)	
	n	%	n	%
Strongly Agree (5)	29	22.3%	26	19.8%
Agree (4)	44	33.8%	42	32.1%
Neutral (3)	43	33.1%	46	35.1%
Disagree (2)	11	8.5%	14	10.7%
Strongly Disagree (1)	3	2.3%	3	2.3%
Missing values	20		19	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1				

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 73; % = 56.2) perceived the *Audio pronunciations* in the HMGs as useful for vocabulary acquisition. Forty-three participants were indecisive (% = 33.1), while fourteen participants (% = 10.8) did not perceive the *Audio pronunciations* as useful. The most frequently occurring rating was *Agree* (Mode = 44; % = 33.8), followed by *Neutral* (n = 43; % = 33.1) with *Strongly Disagree* (n = 3; % = 2.3%) occurring least often. The average rating was 3.65 (SD = ± 0.994).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 68; % = 51.9) perceived the *Audio pronunciations* in the HMGs as useful for reading comprehension. Forty-six participants were indecisive (% = 35.1), while seventeen participants (% = 13.0) did not perceive the *Audio pronunciations* as useful. The most frequently occurring rating was *Neutral* (Mode = 46; % = 35.1%), followed by *Agree* (n = 42; % = 32.1) with *Strongly Disagree* (n = 3; % = 2.3%) occurring least often. The average rating was 3.56 (SD = ± 1.001).

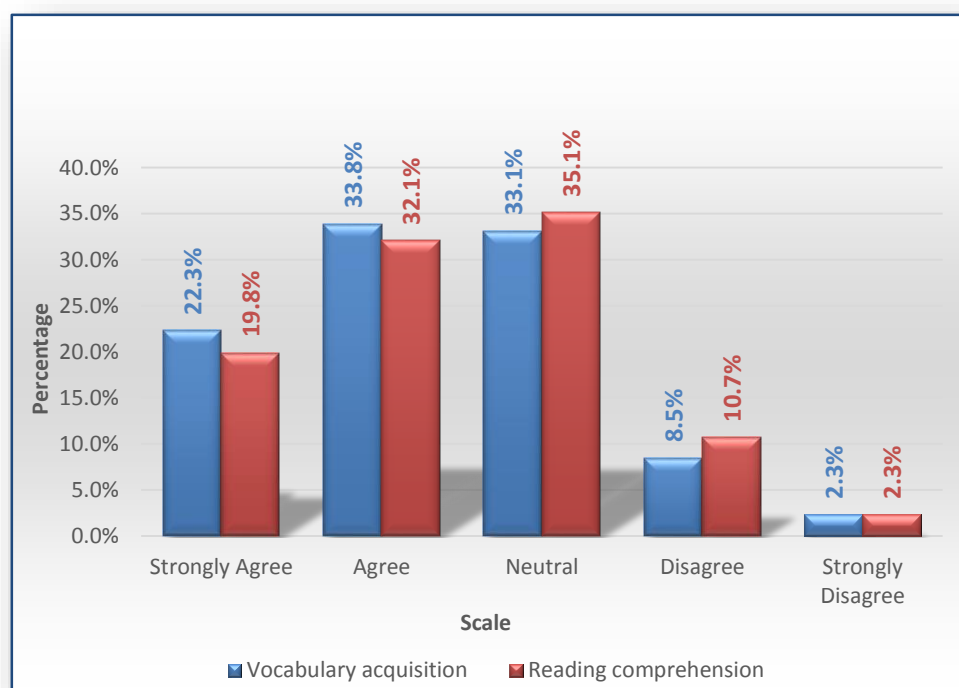


Figure 5-8: Perceived usefulness of audio pronunciations for vocabulary acquisition and reading comprehension

Pictures. The results for “The pictures in the pop-up dictionary helped me learn new words” and “The pictures in the pop-up dictionary helped me understand what I read” are shown in Table 5-16 and Figure 5-9.

Table 5-16: Perceived usefulness of pictures for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x} = 3.52$	SD = ± 1.030	$\bar{x} = 3.63$	SD = ± 1.044
Mode	“Agree” (n = 51)		“Agree” and “Neutral” (n = 39)	
	n	%	n	%
Strongly Agree (5)	20	15.7%	30	24.0%
Agree (4)	51	40.2%	39	31.2%
Neutral (3)	37	29.1%	39	31.2%
Disagree (2)	13	10.2%	14	11.2%
Strongly Disagree (1)	6	4.7%	3	2.4%
Missing values	23		25	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants ($n = 71$; $\% = 55.9$) perceived the *Pictures* in the HMGs as useful for vocabulary acquisition. Thirty-seven participants were indecisive ($\% = 29.1$), while nineteen participants ($\% = 15.0$) did not perceive the *Pictures* as useful. The most frequently occurring rating was *Agree* (Mode = 51; $\% = 40.2$), followed by *Neutral* ($n = 37$; $\% = 29.1$) with *Strongly Disagree* ($n = 6$; $\% = 4.7\%$) occurring least often. The average rating was 3.52 ($SD = \pm 1.030$).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants ($n = 69$; $\% = 55.2$) perceived the *Pictures* in the HMGs as useful for reading comprehension. Thirty-nine participants were indecisive ($\% = 31.2$), while seventeen participants ($\% = 13.6$) did not perceive the *Pictures* as useful. The most frequently occurring rating was *Agree* and *Neutral* (Mode = 39; $\% = 31.2\%$), followed by *Strongly Agree* ($n = 30$; $\% = 24.0$) with *Strongly Disagree* ($n = 3$; $\% = 2.4\%$) occurring least often. The average rating was 3.63 ($SD = \pm 1.044$).

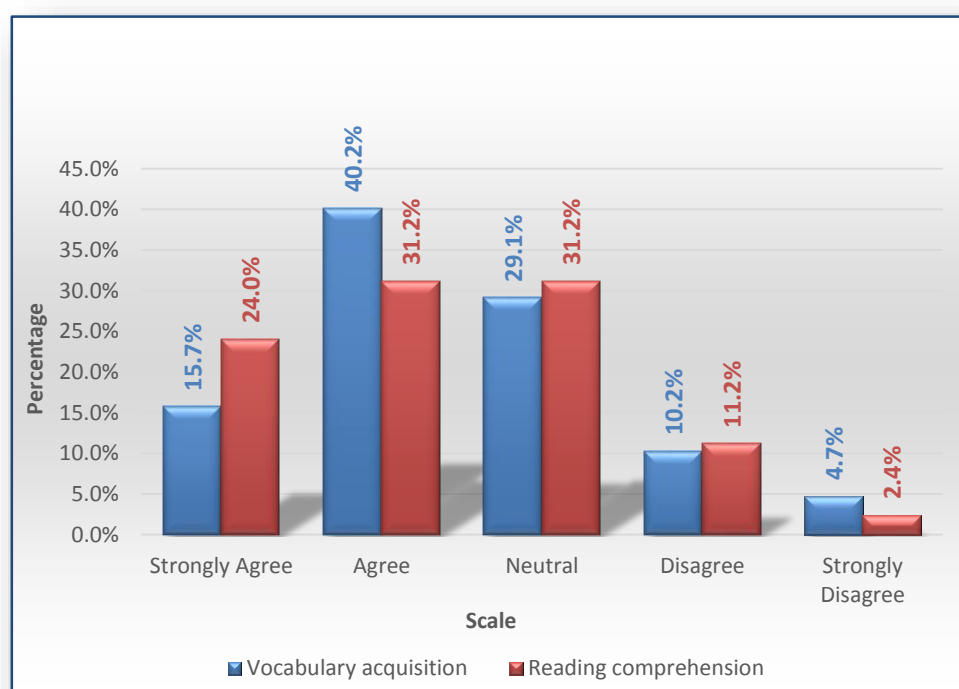


Figure 5-9: Perceived usefulness of pictures for vocabulary acquisition and reading comprehension

Videos & animations. The results for “The videos & animations in the pop-up dictionary helped me learn new words” and “The videos & animations in the pop-up dictionary helped me understand what I read” are shown in Table 5-17 and Figure 5-10.

Table 5-17: Perceived usefulness of videos and animations for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Range ¹	High = 5	Low = 1	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 3.44	SD = $\pm$ 1.038	$\bar{x}$ = 3.51	SD = $\pm$ 1.061
Mode	“Neutral” (n = 45)		“Neutral” (n = 42)	
	n	%	n	%
Strongly Agree (5)	22	17.7%	25	19.7%
Agree (4)	36	29.0%	40	31.5%
Neutral (3)	45	36.3%	42	33.1%
Disagree (2)	17	13.7%	15	11.8%
Strongly Disagree (1)	4	3.2%	5	3.9%
Missing values	26		23	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1				

Usefulness for vocabulary acquisition. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Of the 150 participants, 58 (% = 82.4) perceived the *Videos and animations* in the HMGs as useful for vocabulary acquisition. Forty-five participants were indecisive (% = 36.3), while 21 participants (% = 16.9) did not perceive the *Videos and animations* as useful. The most frequently occurring rating was *Neutral* (Mode = 45; % = 36.63), followed by *Agree* (n = 36; % = 29.0) with *Strongly Disagree* (n = 4; % = 3.2%) occurring least often. The average rating was 3.44 (SD = ± 1.038).

Usefulness for reading comprehension. Ratings ranged from *Strongly Agree* to *Strongly Disagree*. Most of the 150 participants (n = 65; % = 51.2) perceived the *Videos and animations* in the HMGs as useful for reading comprehension. Forty-two participants were indecisive (% = 33.1), while twenty participants (% = 15.7) did not perceive the *Videos and animations* as useful. The most frequently occurring rating was *Neutral* (Mode = 42; % = 33.1%), followed by *Agree* (n = 40; % = 31.5) with *Strongly Disagree* (n = 5; % = 3.9%) occurring least often. The average rating was 3.51 (SD = ± 1.061).

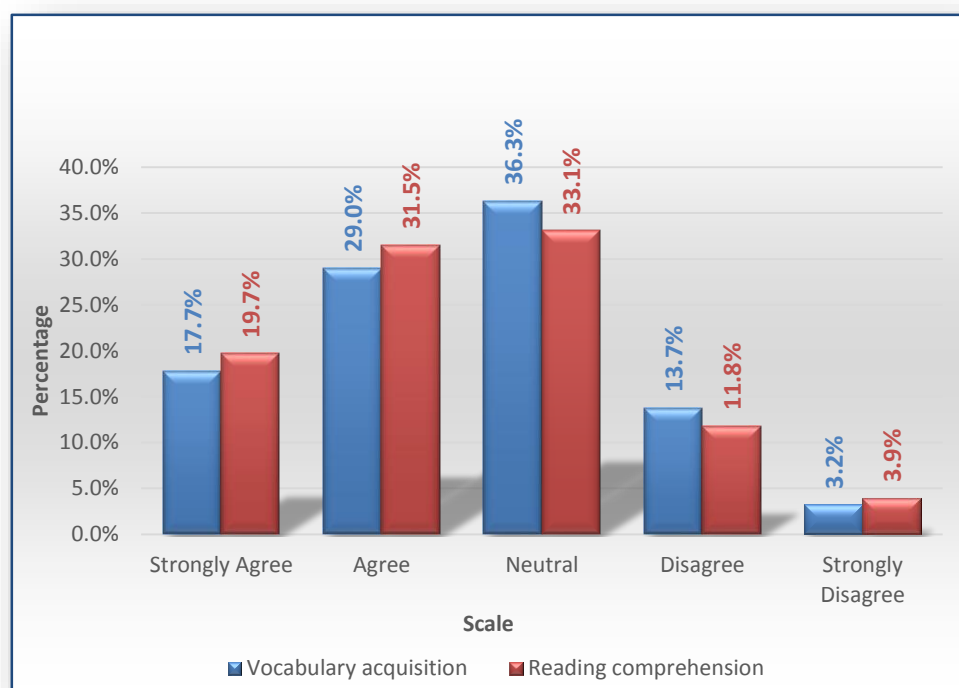


Figure 5-10: Perceived usefulness of videos and animations for vocabulary acquisition and reading comprehension

Most useful elements. The results for “Please indicate the three parts of the pop-up dictionary which were most helpful to you for understanding what you read” are shown in Table 5-18 and Figure 5-11.

Table 5-18: HMG elements perceived as most useful for vocabulary acquisition and reading comprehension

Metric	Vocabulary acquisition		Reading comprehension	
n	150		150	
Mode	“English definitions” (n = 147)		“Agree” (n = 141)	
	n	%	n	%
English definitions	137	91.3%	131	87.3%
Example sentences	86	57.3%	93	62.0%
Words with similar meanings	85	56.73%	84	56.0%
Home language translations	47	31.3%	44	29.3%
Pictures	28	18.7%	31	20.7%
What the word does NOT mean	26	17.3%	22	14.7%
Audio pronunciations	19	12.7%	18	12.0%
Videos & animations	13	8.7%	15	10.0%
Missing values	3		4	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Usefulness for vocabulary acquisition. Most of the 150 participants ($n = 137$; $\% = 91.3$) perceived *English definitions* to be most useful for vocabulary acquisition, followed by *Example sentences* ($n = 86$; $\% = 57.3$), *Words with similar meanings* ($n = 85$; $\% = 56.73$) and *Home language translations* ($n = 47$; $\% = 31.3$). *Pictures* ($n = 28$; $\% = 18.7$), *Explanations of what the word does NOT mean in this sentence* ($n = 26$; $\% = 17.3$), *Audio pronunciations* ($n = 19$; $\% = 12.7$), and *Videos and animations* ($n = 13$; $\% = 8.7$) were perceived as least useful.

Usefulness for reading comprehension. Most of the 150 participants ($n = 131$; $\% = 87.3$) perceived *English definitions* to be most useful for reading comprehension, followed by *Example sentences* ($n = 93$; $\% = 62.0$), *Words with similar meanings* ($n = 84$; $\% = 59.0$) and *Home language translations* ($n = 47$; $\% = 29.3$). *Pictures* ($n = 28$; $\% = 20.7$), *Explanations of what the word does NOT mean in this sentence* ($n = 26$; $\% = 14.7$), *Audio pronunciations* ($n = 19$; $\% = 12.0$), and *Videos and animations* ($n = 13$; $\% = 10.0$) were perceived as least useful.

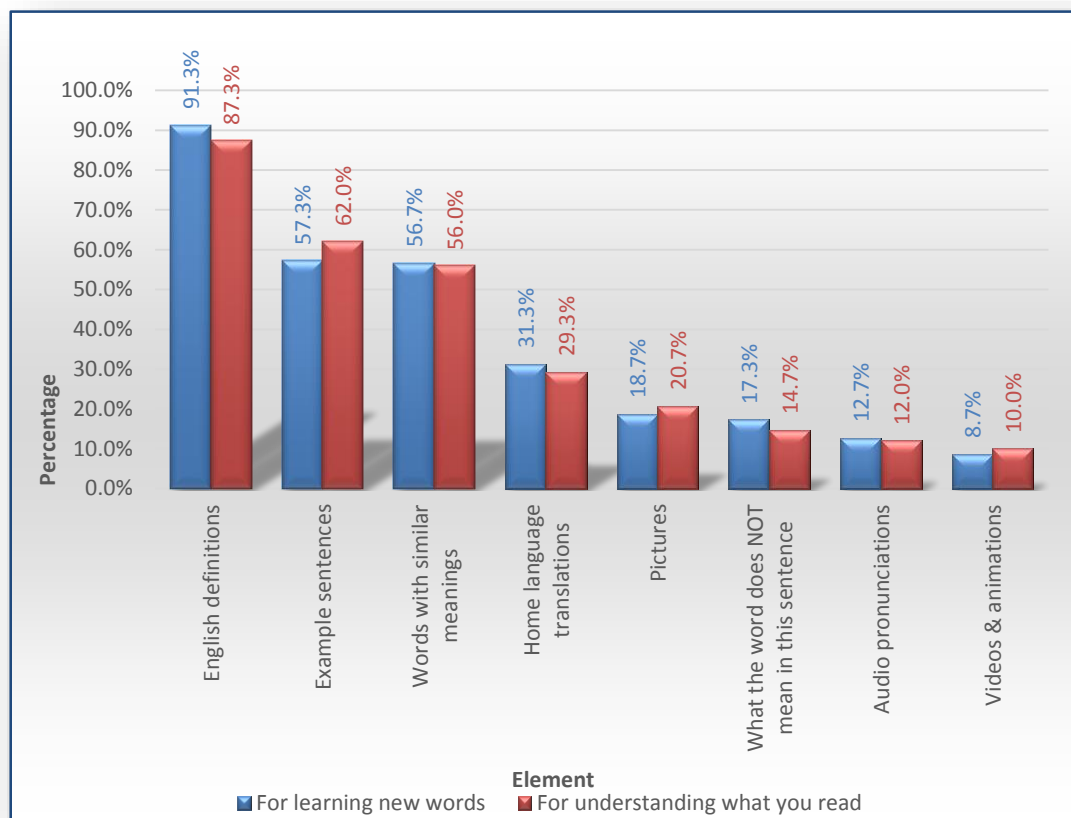


Figure 5-11: Ranking of HMG elements in terms of their perceived usefulness for vocabulary acquisition and reading comprehension

5.3.3.2 Results: Overall usefulness of non-linear lexical HMGs for vocabulary acquisition and reading comprehension

Paying attention. The results for “The pop-up dictionary helped me to pay attention to what I was reading” are shown in Table 5-19 and Figure 5-12.

Table 5-19: Perceived usefulness for paying attention to reading

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 2
Mean ¹	$\bar{x}$ = 4.22	SD = ± 0.671
Mode	“Agree” (n = 76)	
	n	%
Strongly Agree (5)	50	34.7%
Agree (4)	76	52.8%
Neutral (3)	17	11.8%
Disagree (2)	1	0.7%
Strongly Disagree (1)	0	0.0%
Missing values	6	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1		

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 126; % = 87.5) perceived the HMGs as useful for paying attention to what they were reading. Seventeen participants were indecisive (% = 11.8), while one participant (% = 0.7) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Agree* (Mode = 76; % = 52.8), followed by *Strongly Agree* (n = 50; % = 34.7) with *Disagree* (n = 1; % = 0.7%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.22 (SD = ± 0.671).

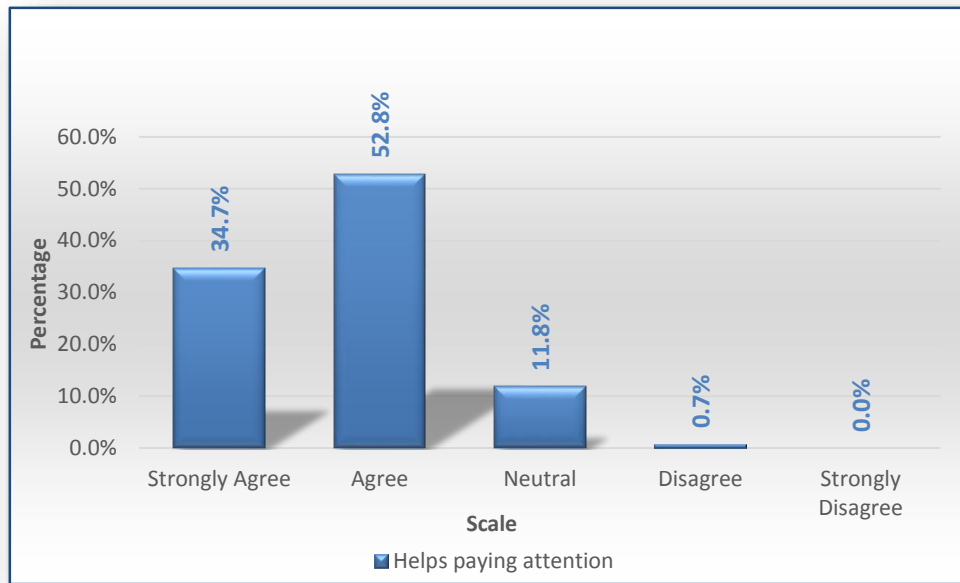


Figure 5-12: Perceived usefulness for paying attention to reading

Learning new words. The results for “The pop-up dictionary helped me to learn new words” are shown in Table 5-20 and Figure 5-13.

Table 5-20: Perceived usefulness for vocabulary acquisition

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 2
Mean ¹	$\bar{x}$ = 4.17	SD = ± 0.645
Mode	“Agree” (n = 81)	
	n	%
Strongly Agree (5)	42	30.0%
Agree (4)	81	57.9%
Neutral (3)	16	11.4%
Disagree (2)	1	0.7%
Strongly Disagree (1)	0	0.0%
Missing values	10	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 123; % = 87.9) perceived the HMGs as useful for paying attention to what they were reading. Sixteen participants were

indecisive (% = 11.4), while one participant (% = 0.7) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Agree* (Mode = 81; % = 57.9), followed by *Strongly Agree* (n = 42; % = 30.0) with *Disagree* (n = 1; % = 0.7%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.17 (SD = ± 0.645).

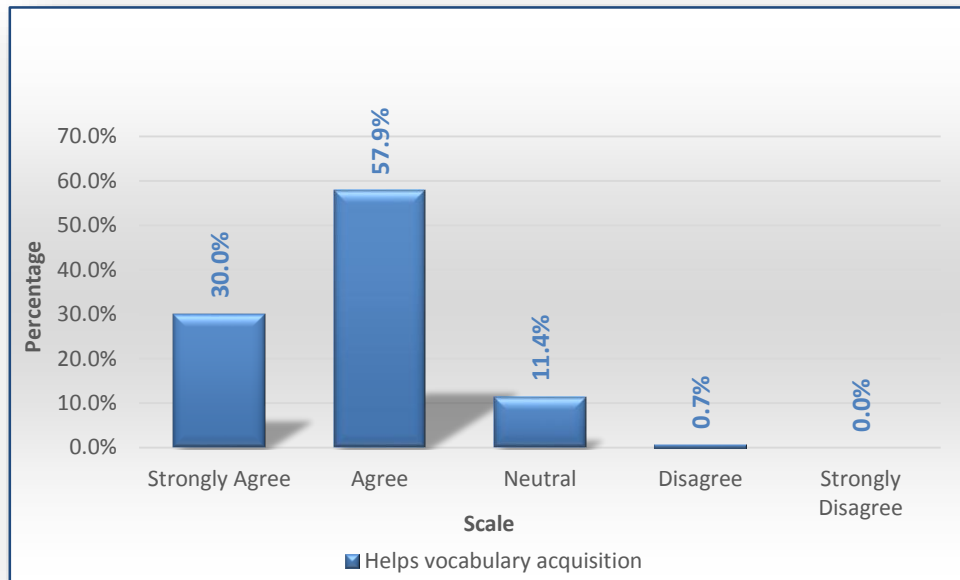


Figure 5-13: Perceived usefulness for vocabulary acquisition

Understanding what I read. The results for “The pop-up dictionary helped me to understand what I read” are shown in Table 5-21 and Figure 5-14.

Table 5-21: Perceived usefulness for reading comprehension

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 2
Mean ¹	$\bar{x}$ = 4.20	SD = ± 0.650
Mode	“Agree” (n = 81)	
	n	%
Strongly Agree (5)	44	31.7%
Agree (4)	81	58.3%
Neutral (3)	12	8.6%
Disagree (2)	2	1.4%
Strongly Disagree (1)	0	0.0%
Missing values	11	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1		

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 125; % = 89.9) perceived the HMGs as useful for paying attention to what they were reading. Twelve participants were indecisive (% = 8.6), while two participants (% = 1.4) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Agree* (Mode = 81; % = 58.3), followed by *Strongly Agree* (n = 44; % = 31.7) with *Disagree* (n = 2; % = 1.4%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.20 (SD = ± 0.650).

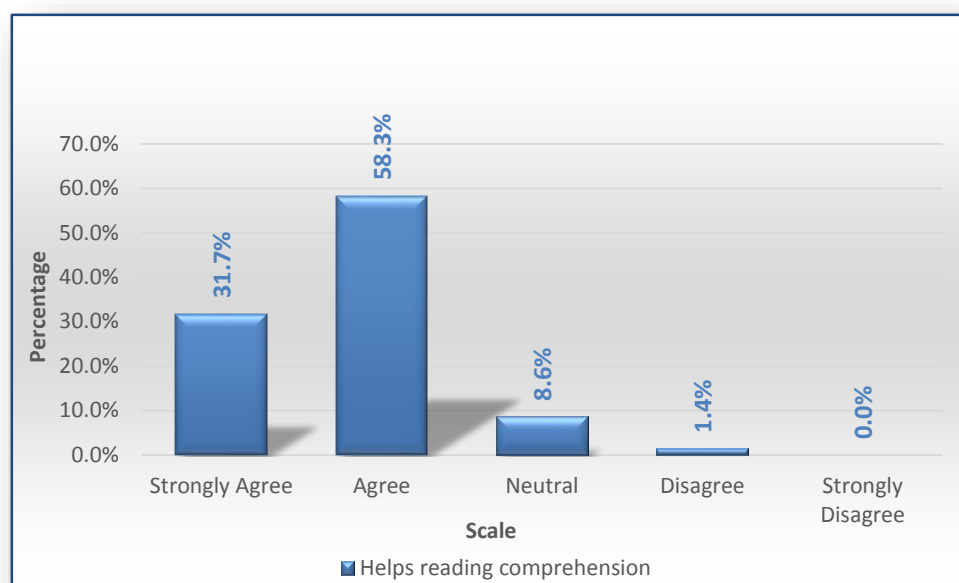


Figure 5-14: Perceived usefulness for reading comprehension

Easy to use. The results for “The pop-up dictionary was easy to use” are shown in Table 5-22 and Figure 5-15.

Table 5-22: Perceived usefulness in terms of ease of use

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 2
Mean ¹	$\bar{x}$ = 4.43	SD = ± 0.696
Mode	“Strongly agree” (n = 78)	
	n	%
Strongly Agree (5)	78	54.2%
Agree (4)	51	35.4%
Neutral (3)	14	9.7%
Disagree (2)	1	0.7%
Strongly Disagree (1)	0	0.0%
Missing values	6	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 78; % = 54.2) perceived the HMGs as useful for paying attention to what they were reading. Fourteen participants

were indecisive (% = 9.7), while one participant (% = 0.7) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Strongly Agree* (Mode = 78; % = 54.2), followed by *Agree* (n = 51; % = 35.4) with *Disagree* (n = 1; % = 0.7%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.43 (SD = ± 0.696).

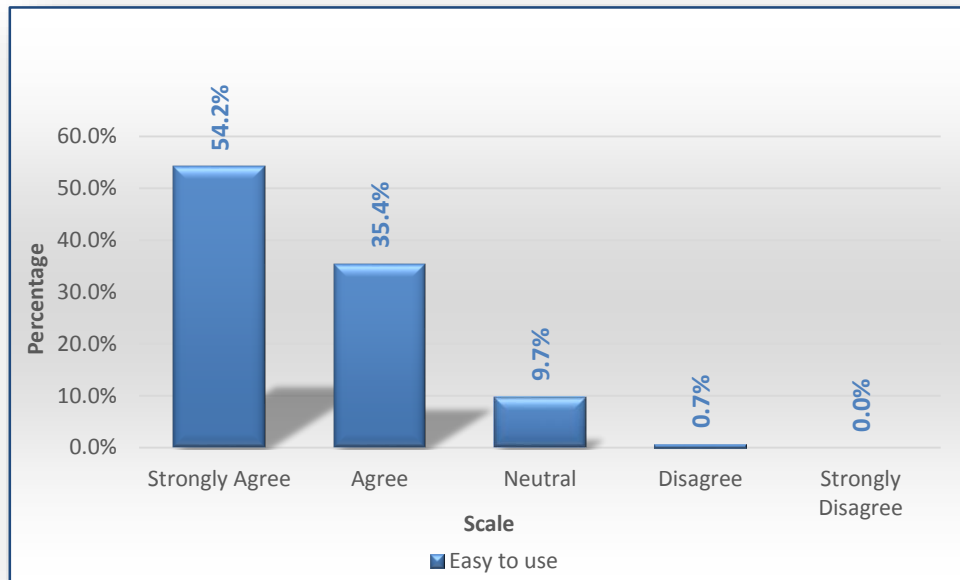


Figure 5-15: Perceived usefulness in terms of ease of use

Clear and understandable. The results for “The pop-up dictionary was clear and understandable” are shown in Table 5-23 and Figure 5-16.

Table 5-23: Perceived usefulness in terms of clarity and understandability

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 4.21	SD = ± 0.869
Mode	“Strongly Agree” (n = 60)	
	n	%
Strongly Agree (5)	60	42.6%
Agree (4)	59	41.8%
Neutral (3)	17	12.1%
Disagree (2)	2	1.4%
Strongly Disagree (1)	3	2.1%
Missing values	9	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1		

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 119; % = 84.4) perceived the HMGs as useful for paying attention to what they were reading. Seventeen participants were indecisive (% = 12.1), while five participants (% = 3.5) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Strongly Agree* (Mode = 60; % = 42.6), followed by *Agree* (n = 59; % = 41.8) with *Strongly Disagree* (n = 3; % = 2.1%) occurring least often. The average rating was 4.21 (SD = ± 0.869).

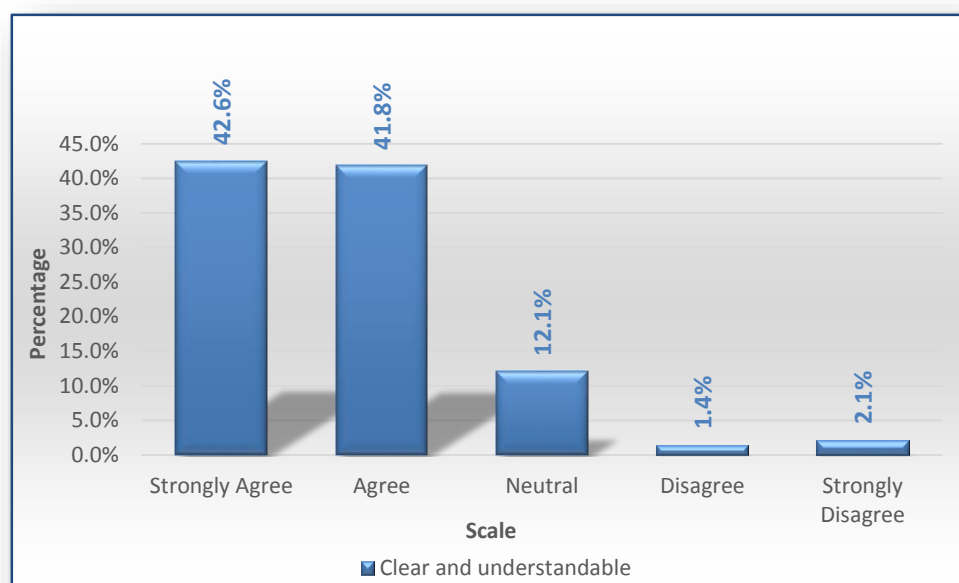


Figure 5-16: Perceived usefulness in terms of clarity and understandability

Makes reading easy. The results for “The pop-up dictionary helped to make reading easy” are shown in Table 5-24 and Figure 5-17.

Table 5-24: Perceived usefulness for making reading easy

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 3
Mean ¹	$\bar{x}$ = 4.28	SD = ± 0.665
Mode	“Agree” (n = 69)	
	n	%
Strongly Agree (5)	58	40.3%
Agree (4)	69	47.9%
Neutral (3)	17	11.8%
Disagree (2)	0	0.0%
Strongly Disagree (1)	0	0.0%
Missing values	6	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 127; % = 88.22) perceived the HMGs as useful for paying attention to what they were reading. Seventeen participants

were indecisive (% = 11.8), while no participants did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Agree* (Mode = 69; % = 47.9), followed by *Strongly Agree* (n = 58; % = 40.3) with *Neutral* (n = 17; % = 11.8%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.28 (SD = ± 0.665).

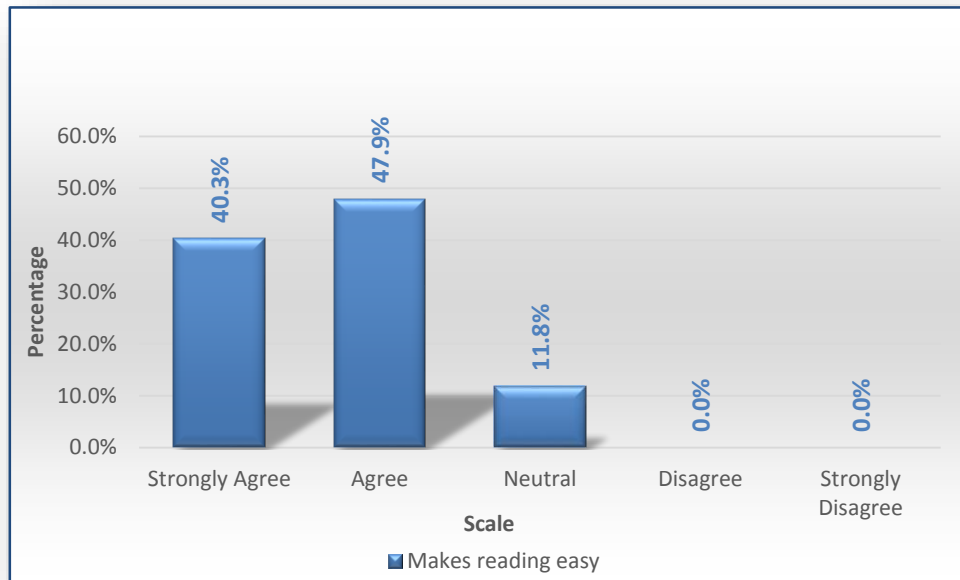


Figure 5-17: Perceived usefulness for making reading easy

Makes reading enjoyable. The results for “The pop-up dictionary helped to make reading enjoyable” are shown in Table 5-25 and Figure 5-18.

Table 5-25: Perceived usefulness for making reading enjoyable

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 1
Mean ¹	$\bar{x}$ = 4.14	SD = ± 0.765
Mode	“Agree” (n = 65)	
	n	%
Strongly Agree (5)	50	35.0%
Agree (4)	65	45.5%
Neutral (3)	27	18.9%
Disagree (2)	0	0.0%
Strongly Disagree (1)	1	0.7%
Missing values	7	
¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1		

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 115; % = 80.4) perceived the HMGs as useful for paying attention to what they were reading. Twenty-seven participants were indecisive (% = 18.9), while one participant (% = 0.7) did not perceive the HMGs as useful for paying attention to what they were reading. The most frequently occurring ranking was *Agree* (Mode = 65; % = 45.5), followed by *Strongly Agree* (n = 50; % = 35.0) with *Strongly Disagree* (n = 1; % = 0.7%) occurring least often. The average rating was 4.14 (SD = ± 0.765).

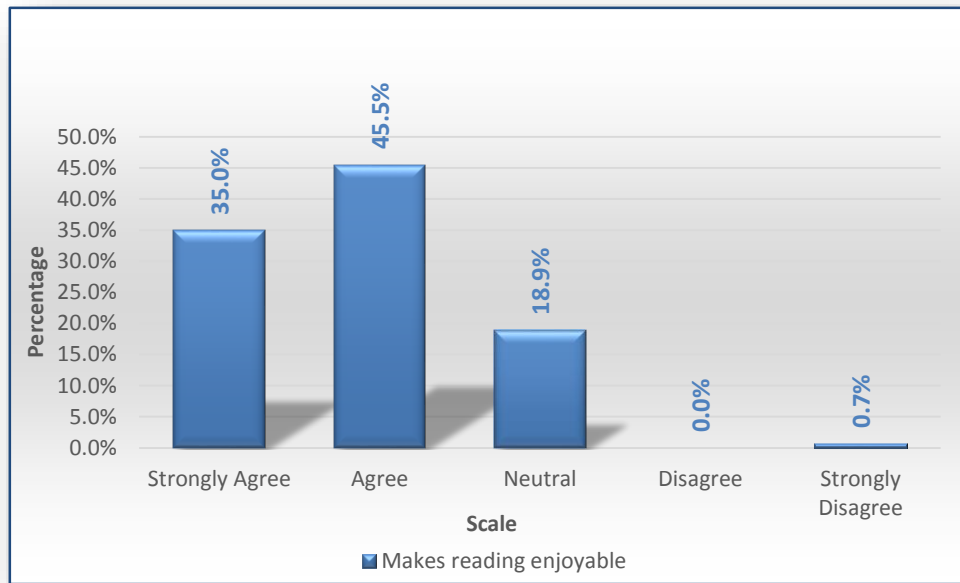


Figure 5-18: Perceived usefulness for making reading enjoyable

Availability when reading. The results for “I would like the pop-up dictionary to be available when I read course material on the computer” are shown in Table 5-26 and Figure 5-19.

Table 5-26: Perceived usefulness expressed in terms of wanting to have HMGs present while reading

Metric	Vocabulary acquisition	
n	150	
Range ¹	High = 5	Low = 2
Mean ¹	$\bar{x} = 4.57$	SD = ± 0.628
Mode	“Agree” (n = 96)	
	n	%
Strongly Agree (5)	96	64.0%
Agree (4)	45	30.0%
Neutral (3)	8	5.3%
Disagree (2)	1	0.7%
Strongly Disagree (1)	0	0.0%
Missing values	0	

¹ Where scores range from “Strongly Agree” = 5 to “Strongly Disagree” = 1

Ratings ranged from *Strongly Agree* to *Disagree*. Most of the 150 participants (n = 141; % = 94.0) perceived the HMGs as useful for paying attention to what they were reading. Eight participants were

indecisive (% = 5.3), while one participant (% = 0.7) did not perceive the HMGs as useful for paying attention to what he/she was reading. The most frequently occurring ranking was *Strongly Agree* (Mode = 96; % = 64.0), followed by *Agree* (n = 45; % = 30.0) with *Disagree* (n = 1; % = 0.7%) occurring least often. No participant strongly disagreed that the HMGs were useful for paying attention to what they were reading. The average rating was 4.57 (SD = ± 0.628).

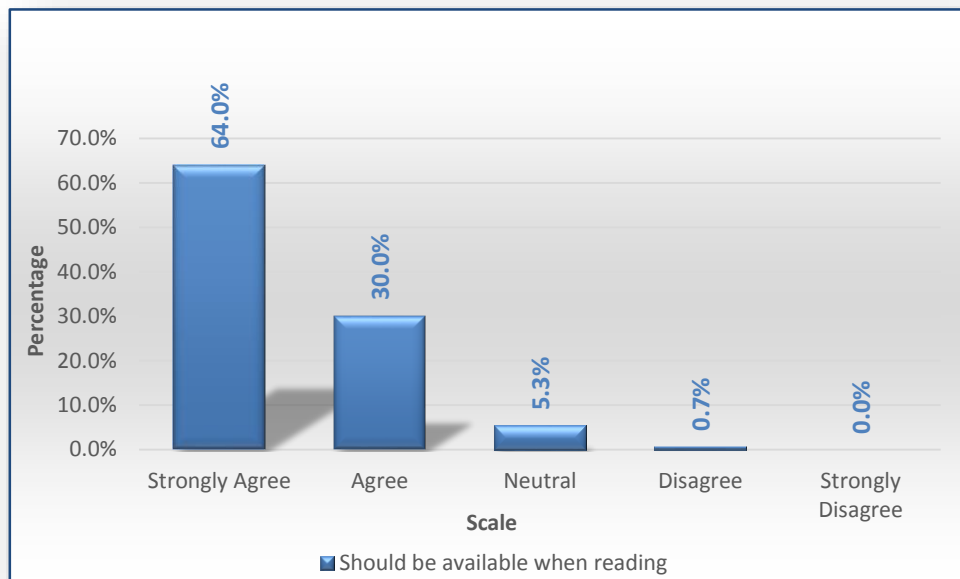


Figure 5-19: Perceived usefulness expressed in terms of wanting to have HMGs present while reading

5.3.3.3 Relationship between aspects of perceived usefulness of non-linear lexical HMGs and actual vocabulary and comprehension scores

The relationship between perceived usefulness ratings, the actual scores for the three administrations of the text-specific vocabulary test, and the comprehension test was determined using Spearman's rank-order correlation. The results are shown in Table 5-27.

Table 5-27: Spearman's rho correlation between overall perceived usefulness and actual test scores

		Overall usefulness question: Learning new words	Overall usefulness question: Understanding what I read	Perceived usefulness for vocabulary acquisition	Perceived usefulness for reading comprehension	Perceived overall usefulness	Text-specific vocabulary pre-test	Reading comprehension test	Immediate text-specific vocabulary post-test	Delayed text-specific vocabulary post-test
Overall usefulness question: Learning new words	Correlation Coefficient	1.000	0.636**	0.560**	0.556**	0.680**	-0.077	0.016	-0.019	0.091
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.528	0.852	0.831	0.383
	N	140	135	140	140	140	70	137	132	94
Overall usefulness question: Understanding what I read	Correlation Coefficient	0.636**	1.000	0.528**	0.600**	0.781**	0.048	0.038	0.105	0.198
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.694	0.657	0.234	0.054
	N	135	139	139	139	139	69	136	131	96
Perceived usefulness for vocabulary acquisition	Correlation Coefficient	0.560**	0.528**	1.000	0.850**	0.602**	0.061	-0.036	-0.075	-0.065
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.485	0.667	0.381	0.517
	N	140	139	148	148	148	74	144	140	100
Perceived usefulness for reading comprehension	Correlation Coefficient	0.556**	0.600**	0.850**	1.000	0.633**	0.082	-0.066	-0.039	-0.012
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.485	0.431	0.648	0.905
	N	140	139	148	149	149	75	144	141	101
Perceived overall usefulness	Correlation Coefficient	0.680**	0.781**	0.602**	0.633**	1.000	0.157	0.083	0.019	0.150
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.179	0.322	0.825	0.135
	N	140	139	148	149	150	75	145	142	101
Text-specific vocabulary pre-test	Correlation Coefficient	-0.077	0.048	0.061	0.082	0.157	1.000	0.499**	0.869**	0.831**
	Sig. (2-tailed)	0.528	0.694	0.607	0.485	0.179		0.000	0.000	0.000
	N	70	69	74	75	75	143	138	130	98
Reading comprehension test	Correlation Coefficient	0.016	0.038	-0.036	-0.066	0.083	0.499**	1.000	0.487**	0.521**
	Sig. (2-tailed)	0.852	0.657	0.667	0.431	0.322	0.000		0.000	0.000
	N	137	136	144	144	145	138	307	285	205
Immediate text-specific vocabulary post-test	Correlation Coefficient	-0.019	0.105	-0.075	-0.039	0.019	0.869**	0.487**	1.000	0.765**
	Sig. (2-tailed)	0.831	0.234	0.381	0.648	0.825	0.000	0.000		0.000
	N	132	131	140	141	142	130	285	290	194
Delayed text-specific vocabulary post-test	Correlation Coefficient	0.091	0.198	-0.065	-0.012	0.150	0.831**	0.521**	0.765**	1.000
	Sig. (2-tailed)	0.383	0.054	0.517	0.905	0.135	0.000	0.000	0.000	
	N	94	96	100	101	101	98	205	194	308
** Correlation is significant at the 0.01 level (2-tailed).										

The table shows strong, practically significant positive correlations at the 0.01 level between the dimensions of the user experience survey. As an example, the question *The pop-up dictionary helped me to learn new words* showed strong, practically significant positive correlations at the 0.01 level with:

- *The pop-up dictionary helped me to understand what I read* ($r_s = 0.636$, $p = 0.000$),

- *Perceived usefulness for vocabulary acquisition* ($r_s = 0.560$, $p = 0.000$),
- *Perceived usefulness for reading comprehension* ($r_s = 0.556$, $p = 0.000$), and
- *Perceived overall usefulness* ($r_s = 0.680$, $p = 0.000$).

Similarly, the correlations between the various test scores themselves were medium to strong, positive and practically significant at the 0.01 level. For example, the *Text-specific vocabulary pre-test* showed medium to strong, practically significant positive correlations at the 0.01 level with:

- *Reading comprehension test* ($r_s = 0.499$, $p = 0.000$),
- *Immediate text-specific vocabulary post-test* ($r_s = 0.869$, $p = 0.000$), and
- *Delayed text-specific vocabulary post-test* ($r_s = 0.831$, $p = 0.000$).

There were, however, no significant correlations between the usefulness ratings in respect of vocabulary acquisition and reading comprehension on the one hand, and actual test scores achieved on the other.

5.4 CHAPTER SUMMARY

This chapter conveyed the initial results and analyses of measurements collected during the study. Descriptive statistics related to the demographic composition of the participants in this study, and measures describing the concentration and dispersion of measurements were conveyed.

The results from the user experience survey showed that participants perceived HMGs as useful for vocabulary acquisition and reading comprehension. They found HMGs easy to use, rating them as useful for aspects such as aiding in paying attention to reading, and making reading easy and enjoyable. They would prefer having glosses available when they read course material. This favourable perception is not evident from the measured effect of glosses on vocabulary and reading comprehension. The study found no practically significant effect of HMGs on either vocabulary or reading comprehension.

Chapter Six will revisit the research question posed by this study by way of addressing each of the sub-questions. The methodological and theoretical significance of the study will be considered and limitations of the study will be discussed. The chapter will conclude by discussing the implication of findings on the facilitation of learning and making recommendations regarding the possible direction of future research.

DISCUSSION, LIMITATIONS AND RECOMMENDATIONS, AND CONCLUSION

6.1 INTRODUCTION

In Chapter Five, rigorous data analysis procedures were followed to extract descriptive and inferential statistics from the collected data. This chapter discusses the findings of the study in respect of the sub-questions with reference to the analyses presented there. It considers the significance of the study and identifies its limitations. Guidelines are drawn up to facilitate implementation of lessons learnt. These guidelines focus on the use of learning technologies in the process of facilitating vocabulary acquisition and reading comprehension. Finally, recommendations for future research are made.

6.2 REVISITING THE RESEARCH QUESTION

A multi-faceted research question was posed by this study. Instead of answering the question exhaustively, it was partially addressed with reference to three sub-questions. No hypotheses were tested in this study. The purposive sampling strategies in this study resulted in samples being non-representative. As a consequence no inferences about any broader population should be drawn from the findings about the characteristics of the sample (Babbie, 2015:451).

In the following sections, the analysis of collected data presented in Chapter Five are discussed with reference to the three sub-questions. Results from this study are compared with theories and explanations from the body of literature during a process of nomothetic meaning making, leading to an explanation of the effect of HMGs on vocabulary acquisition and reading comprehension as it applies to the sample (Babbie, 2011:392; Babbie, 2015:22-23).

6.2.1 Discussion: How will non-linear lexical HMGs accessible during an English reading comprehension task affect English vocabulary acquisition of readers?

The expectation was for a significant difference in the text-specific vocabulary size test scores of the participants in the treatment groups when compared to the control groups (Yun, 2011:65). Participants in the treatment groups were free to access glosses when and for as long as they needed to. Readers with poor ELS might have used this freedom to access glosses more frequently than those with better ELS. The increased HMG access frequency, aided by the ease with which HMGs could be accessed, would have caused such readers to repeatedly pay attention to the glossed word. Consequently readers with poor ELS, such as are often found at TUT, could have benefited from a larger effect on the vocabulary (Aust *et al.*, 1993:63; Beck *et al.*, 2013:5; Chun & Payne, 2004:497-499; Davis & Lyman-Hager, 1997:62;

Hulstijn *et al.*, 1996:336; Nation, 2001:175-176; Roby, 1991:iii; Wittrock, 1989:348; Yanguas, 2009:60; Yun, 2011:75).

Previous studies have shown a significant decrease in text-specific vocabulary scores between the immediate post-test to the delayed post-test. Even after the time induced attrition, the delayed post-tests still showed an overall gain over pre-test scores (Akbulut, 2007:510; Al Ghafli, 2011:85; Yanguas, 2009:60). These studies, however, used a two or three week interval between the treatment and the delayed post-test. In this study, student-related and other complications led to the delayed post-test only being administered eight weeks after the treatment. Had it not been for the longer delay, the expectation for this study would have been for a similar time-induced attrition. The longer delay in an academic environment where the LoLT is English, increased the opportunity for vocabulary gains through incidental learning. Higher scores on the delayed post-test than on the immediate post-test would therefore not be altogether surprising.

Between-group effects were reported for the treatment itself, for the pre-test, for incidental learning from the vocabulary test, for the interaction of the pre-test on the treatment, and for the total effect on estimated mean vocabulary scores. The results of all four groups showed no practically significant differences in immediate post-treatment vocabulary scores or delayed post-treatment vocabulary scores between the treatment and control groups. There were also no practically significant differences between the pre-tests and immediate post-tests or between the immediate and delayed post-tests within the four experimental groups.

A number of explanations for the smaller than expected effect on vocabulary can be advanced:

- The estimated mean scores were high, even in the pre-test. Expansive vocabularies might have reduced the need to access HMGs, which in turn would have limited their potential effect on vocabulary acquisition.
- The language used in explanations were mostly taken verbatim from dictionary websites. The vocabulary and level of language used in those explanation may have been beyond the vocabulary and language skill of some participants. As a consequence, HMGs might not have contributed to readers acquiring the meaning of unknown words.
- While low proficiency readers were likely to benefit most from HMGs, they were also most vulnerable to the effect of sub-optimal gloss access strategies. The cognitive load imposed by multimedia-enriched glosses could easily have overburdened their working memory capacities, which in turn could have negated the potential benefit from accessing the glosses (Yun, 2011). Davis and Lyman-Hager (1997:68) as well as Sakar and Ercetin (2005:37) suggest that readers be trained in the optimal use of HMGs. To prevent the overburdening of working memory, training could, for example, include

making readers aware of their own cognitive strengths and constraints, and how to adapt gloss access and use to their own working memory capacities.

- Adding to the previous: the participants were at the very beginning of their first year at university. The new environment, test anxiety and being unfamiliar with computers and computerised tests might all have been too overwhelming for the participants. The perceived need to finish tests quickly could have affected participants' willingness to access glosses when necessary, which could have limited the potential benefit to vocabulary learning.
- Heckler (2011:251) describes test behaviour where time constraints play a role in decision making. In such situations, when competing plausible options are presented to students, they tend to select the option which requires the shortest cognitive processing period. Removing the time constraint then allows students the time to evaluate all options thoroughly, which in turn leads to better choices being made. In the context of a multiple choice test where students perceive a need to finish quickly, their choice of an option could have been influenced by the plausibility of the options and the time required to evaluate each option.

Authors like Nagy (2010:72, 76) maintain that vocabulary can be acquired incidentally from context when reading. Having the treatment immediately following the pre-test could also have primed participants to look up certain unfamiliar words. It is therefore conceivable that the pre-test and the possible interaction between the pre-test and the treatment could have influenced results. Using a four group design allowed for exploring the effect of the pre-test, of incidental learning and of the interaction between the pre-test and the treatment on estimated mean vocabulary scores. While the second analysis no longer showed any practically significant effects, some of the effects were slightly elevated, and the results from the initial analysis did show a practically visible effect of incidental learning on vocabulary scores.

6.2.2 Discussion: How will non-linear lexical HMGs accessible during an English reading comprehension task affect English reading comprehension of readers?

The picture describing the effect of HMGs on reading comprehension is not all that clear. Some studies have shown that HMGs are effective for supporting reading comprehension (Lomicka, 1998:41; Taylor, 2006:310). Others have found no beneficial effect on reading comprehension (Ariew & Ercetin, 2004:237). Some studies have even found HMGs to be a hindrance to reading comprehension (Sakar & Ercetin, 2005:28). For these reasons, no clear expectation existed regarding the effect of HMGs on reading comprehension in this study.

Both the type of HMG and constraints in working memory capacity might have played a role. Glosses in this study were developed to explain unknown words, not to provide support for understanding the context within which unknown words appeared. The low levels of English language skills prevalent at TUT

could well have made working memory overload likely. These factors all agitate for little or no effect of HMGs on reading comprehension. Reading comprehension might even have been hindered by glossing (Plass *et al.*, 2003:221, 227).

On the other hand, control over gloss access patterns and frequency was with the readers. Media elements were not displayed in the glosses by default, but had to be invoked by clicking the appropriate icon. Readers were therefore able to modify their gloss usage behaviour to their own working memory capacities. Reading is made more meaningful when readers are actively involved in the reading process, deciding for themselves how much time to spend on glosses, at what pace to read and how to go about making meaning from the text and from gloss content. The possibility of a positive effect of HMGs on reading comprehension could therefore not be excluded (Chun & Payne, 2004:497-499; Erçetin, 2003:279; Plass *et al.*, 2003:236, 239; Sweller, 2011:62; Taylor, 2009:153-154).

Effects on estimated mean reading comprehension scores were reported for the treatment itself, the pre-test, the interaction of the pre-test on the treatment, and the total effect. No practically significant effects on estimated mean reading comprehension scores were found for any of the aspects examined. As was discussed in § 6.2.1, the pre-test and the interaction of the pre-test on the treatment might have influenced estimated mean vocabulary and reading comprehension scores. It appears as if that was not the case in this study, although the practical effect sizes for the pre-test (small effect size = 0.20) and the interaction (small effect size = 0.37) were slightly elevated. These results warrant that thought be given to isolating these effects from the main treatment effect in similar studies.

To explain the absence of practically significant effect of the treatment on reading comprehension, a number of reasons can be advanced:

- The findings are consistent with some previous studies (Ariew & Ercetin, 2004:237; Chun, 2007:242-243, 245; Davis & Lyman-Hager, 1997:68; Sakar & Ercetin, 2005:28) which have also not found a practically significant positive effect, with some even finding a negative effect on reading comprehension.
- Glosses were designed to support readers' acquisition of word meanings, rather than provide information about the context within which the unknown words occur. Plass *et al.* (2003:227) suggest that glosses have to provide such contextual information for them to support reading comprehension.
- The HMGs could have caused a split attention effect where focusing on the explanation of the meaning of the word in the gloss drew attention away from meaning of the text (Sweller, 2011:66).
- The text book from which comprehension texts were extracted was written by authors with advanced knowledge of Accounting, which was the subject area of the comprehension text. Authors may

choose their wording under the assumption that the reader possesses an adequate level of subject knowledge to be able to understand the text without further elaboration on the assumingly known content. Someone with no background knowledge will then not have the ability to make meaning of the text. As such, a comprehension test measures a certain level of background knowledge as much as it measures the reader's ability to make meaning from a text simply from the words used in the text. A lexical gloss such as used in this study will clarify the meaning of the words used, but won't provide all the contextual background information necessary to make meaning of the text (Fulcher, 1998:283-285; Widdowson, 1984:169).

- Alternatively, some text definitions, images and animations might simply not adequately explain the meaning of the unknown word(s) to the reader. These definitions used in the HMGs could have been responsible for misunderstanding the reading tests. Homonyms, for example, are difficult to define, as their meanings are understood from the contexts in which they occur. Glossing for one specific meaning, but then encountering the word in text where it has a different meaning, might well have the effect that the glossed meaning of the word is learnt, but text comprehension is hindered. Care was taken to define terms according to their meaning in the context in which they occurred in the text, but that was not possible when multiple meanings of the homonyms occurred in the same text. In such cases, both meanings were explained, but selecting the inappropriate definition could have affected readers' reading comprehension. Certain imagery used in the glosses might be embedded in a specific culture grouping, but may be entirely foreign to another. Using an animated illustration of Cinderella's transformation from servant girl to princess as a visual representation of "transform" might be familiar in Western culture, but might well be unfamiliar in some African cultures. Having a large enough collection of glossed terms might, however, sufficiently mitigate the detrimental effect of an inadequate gloss definition. By ensuring that enough other words in the text are understood, the lexical coverage required to make meaning of the text might still be achieved.
- Again, as mentioned in § 6.2.1, participants might simply not have used the glosses appropriately to their working memory capacities. They might even not have used them at all, perhaps as a result of trying to answer questions quickly rather than correctly. Under-developed mouse skills could also have hindered their gloss access frequency. If glosses were not accessed, they would obviously not have had an influence on reading comprehension.

6.2.3 Discussion: How will readers perceive the usefulness of non-linear contextual lexical HMGs accessible during an English reading comprehension task?

Having been exposed to the treatment during this study, participants from Groups A and C were invited to complete a user-experience survey. The survey recorded participants' ratings of perceived usefulness

of HMG elements for vocabulary acquisition, reading comprehension and overall usefulness. These ratings are discussed in the following paragraphs.

- **Rating of elements**

There is some previous evidence that the order of reader preference for HMG elements is images, followed by video, audio and text (Sakar & Ercetin, 2005:36). Similar to Davis and Lyman-Hager (1997:61), readers in this study, however, rated textual elements higher than multimedia elements. Participants in this study perceived all the textual HMG elements as useful, with the majority either agreeing or strongly agreeing that the elements helped them to learn new words and to understand what they read.

The multimedia elements—audio pronunciations, pictures, and videos and animations—were not perceived to be as useful as textual elements. More participants rated these elements positively than negatively, but a large number of participants were neutral about their usefulness, so that the majority of students rated the multimedia elements either neutrally or negatively. There were, however, still more participants who agreed that pictures were useful for vocabulary acquisition and reading comprehension than for any other rating. More participants than were neutral agreed that audio pronunciations were useful for vocabulary acquisition, but the reverse was true for reading comprehension. Participants considered videos and animations least useful, with participants being neutral about the usefulness of videos and animations for vocabulary acquisition and reading comprehension forming the largest group.

The highest rated element in terms of its perceived usefulness for both vocabulary acquisition and reading comprehension was the “English definitions.” This was followed by “Example sentences,” “Words with similar meanings” and “Explanations of what the word does NOT mean in this sentence.” “Pictures” and “Videos & animations” were the lowest ranked elements.

That textual elements were considered more useful than multimedia elements might be explained by all words having textual elements, while not all HMGs had pictures, videos and animations. Textual elements are also always available while an HMG is being accessed. Multimedia elements are, however, not visible by default. Listening to or viewing a multimedia element requires a reader to click the relevant icon which plays or displays the element. If the textual elements had contained enough information to decode the unknown word, the readers might not have considered it necessary to launch a multimedia element.

Several other factors might have contributed to multimedia elements receiving low ratings. These elements were not played or displayed by default when HMGs were accessed. Accessing them

required an additional click, and this additional click might have discouraged users who had little or no previous experience in navigating a computer with a mouse. Test anxiety and a concomitant perception of urgency to complete the assessments as quickly as possible may have caused students not to spend the extra time required to access the multimedia elements.

The mediocre ratings and rankings of audio pronunciations were expected. The finding corresponds with Ariew and Ercetin (2004:253), whose study found that audio pronunciations are not considered useful for comprehension, but are considered useful for providing information regarding the proper pronunciation of words.

- **Accessing L1 translations**

At the recommendation of Beck *et al.* (2013:171), L1 translations were provided in the glosses as these may supplement vocabulary instruction for struggling students. Previous studies have also found a strong preference of readers for L1 translations of unknown ESL terms when they are available (Aust *et al.*, 1993:63; Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:58, 61; Taylor, 2006:314). That was also the expectation for this study, but the findings from the user experience survey do not show such a strong preference. This could have been caused by the translations not being permanently visible in the glosses. Instead, translations can be accessed by selecting the relevant home language from a drop-down list, which then retrieves the appropriate translation. Requiring the additional user interaction might have discouraged the use of translations. Another plausible explanation can perhaps be found in the fact that many of the South African languages are not used as academic languages at institutions of learning. English, although the second language, then becomes the academic language. In such a scenario accessing the L1 translation might have limited value, especially if the translated term is unknown or less familiar to the reader than the English term.

- **Enjoyment of reading, availability of HMGs when reading and actual performance**

Readers were expected to perceive lexical HMGs as useful, being easy to use, making reading enjoyable and making texts easier to understand. Readers were expected to show a predilection for reading material to be supported by HMGs. Students' self-reporting, however, shows little relationship to actual performance, so that this positive attitude towards reading with HMGs was not expected to correlate strongly with actual vocabulary acquisition and reading comprehension test

scores⁸ (Ariew & Ercetin, 2004:253; Davis & Lyman-Hager, 1997:67; Sakar & Ercetin, 2005:28).

Findings of this study support the expectation of a favourable perception of students regarding the overall usefulness of HMGs. There was a strong positive correlation between the various sections of the user experience survey. Participants rated the usefulness of HMGs highly in respect of aspects such as vocabulary acquisition, reading comprehension, ease of use, making reading enjoyable, and other dimensions measured. These high ratings did not, however, translate into practically significant improvements in vocabulary and reading comprehension scores. The study therefore confirms the absence of significant correlations between participants' self-reporting and actual performance in vocabulary and reading comprehension assessments.

6.3 SIGNIFICANCE OF THE STUDY

This is not the first study of its kind internationally. However, no previous South African studies into the use of HMGs for supporting vocabulary acquisition and reading comprehension could be found. The methodological and theoretical significance of the study are discussed in the following two sections.

6.3.1 Methodological significance

Many of the studies examined used research designs aimed at comparing the effect of different gloss types on vocabulary acquisition and reading comprehension (Akbulut, 2007; Al Ghafli, 2011; Ben Salem, 2007). This study departed from such a design, believing that optimal glossing can be found in defining all words in a text with any appropriate media type which could contribute to clarifying the meaning of a word, but allowing reader control over which glosses to access.

A Solomon four group design (Solomon, 1949:145) was used in this study. Having one test group-control group pairing with a pre-test and another without the pre-test allowed the effect of the pre-test on vocabulary acquisition and reading comprehension to be isolated. The interaction effect of the pre-test on the treatment, as well as changes in vocabulary due to incidental learning from the comprehension text, could also be examined.

In previous studies, readers have shown a strong preference for accessing L1 translations for unknown L2 words (Aust *et al.*, 1993:63; Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:61). For that reason,

⁸ The *emotional interest hypothesis* poses that interesting information provided to supplement learning material will make the learning experience enjoyable to the learner. This will in turn increase the learner's intrinsic motivation, so that the learner pays more attention and works harder to make meaning of the learning material. In contrast, Mayer's CTML proposes that learning is optimised when the central constructs are isolated and engaged with in a process of meaning making. Within this (CTML) theoretical framework, the *seductive details hypothesis* provides a possible explanation why readers' enthusiasm for HMGs do not necessarily translate into improved learning performance. Redundant information, interesting but not essential for the central construct to be understood, draws attention away from the central construct. The redundant information overloads scarce working memory resources, and learning is hindered (Mayer, 2011:80-82; Mayer *et al.*, 2001:193).

L1 translations were made available in the glosses used in this study. There are eleven officially recognised languages in South Africa. A number of other local African languages are also spoken, but are not officially recognised. Add to these the foreign languages spoken, and the difficulty with providing a first language translation in the gloss becomes evident. Using drop-down selections in the gloss, the HMG system was developed to allow users to select a first language of choice. During this study, the official South African languages were catered for, but other languages can be catered for by the system with little additional effort.

Beck *et al.* (2013:43-44) are critical of the text definitions typically found in dictionaries, considering them ineffective, limiting and confusing. Following their recommendations, text elements in glosses were extended beyond mere dictionary definitions to contain example sentences, contextually similar words, and indication of those meanings of the selected word which are not applicable to the context in which they occurred.

6.3.2 Theoretical significance

This study investigated the contribution that L2 HMGs augmented with L1 translations could make towards supporting vocabulary acquisition and reading comprehension. Students can be served by HMGs both in the classroom and at a distance, away from the classroom. It poses an alternative to the traditional approach at TUT of combining computerised language learning software with face-to-face remediation. As it can be integrated into the institutional VLE, some of the challenges connected to providing equitable language support offerings across the multiple learning sites that make up TUT, can also be addressed. The intervention is embedded unobtrusively within the electronic learning material of a specific subject, and is accessible whenever required by the student.

Participants in this study assigned a low rating to first language translations. This was surprising, considering the recommendation by Beck *et al.* (2013:171) to use L1 translations, and the strong preference for L1 translations found in previous studies (Aust *et al.*, 1993:63; Chun & Payne, 2004:498; Davis & Lyman-Hager, 1997:61). This finding, however, might be situational to a context where many of the participants only ever learnt in English, and their first languages are not developed as academic languages. In such a context, readers might be more familiar with the English term than with the term used in the first language translation. The first language translation of subject related jargon might even be unknown to some readers.

6.4 LIMITATIONS OF THE STUDY

It is considered as prudent to evaluate the research findings of the study against its limitations. These limitations have implications for both theory and practice.

6.4.1 Theoretical limitations of the study

Fletcher (2006:323-324, 328) points out that reading comprehension as a construct is complex and multi-dimensional. He concludes that a multi-methodological approach to assessment is necessary to measure reading comprehension validly. The inferences that can be drawn about reading comprehension from a multiple-choice test such as was employed in this study are limited, and should be evaluated in that light. Using a multi-methodological approach might have rendered different results.

Vocabulary knowledge is similarly multi-dimensional. The multiple-choice test employed in this study, with the stem and response alternatives composed in ESL, measures only one dimension, namely the readers' passive recognition of the meaning of an ESL term from a list of options. Using tests measuring different dimensions of vocabulary knowledge, such as active or productive measures, might have yielded different results to the text-specific vocabulary tests.

6.4.2 Methodological and practical limitations of the study

Hughes (2003:33) makes the statement that a high stakes test, where results can have a serious impact on the lives of participants and others, should be fully validated before being administered. On the other hand, teacher-made tests such as were used in this study, are not likely to be fully validated. Some of the threats to validity claims discussed in § 4.6.3.2 are repeated here. This will allow the reader to assimilate the results from this study into a working hypothesis through naturalistic generalisation for application in his or her own context.

- The reading comprehension test was only marginally reliable. Low levels of English language proficiency, such as are commonly found at TUT, may have contributed to the low test-item response reliability (Abedi, 2002:231). The test is a low stakes test, and within TUT no harmful backwash is expected to flow from the results of the test. Due caution should be exercised by external users when evaluating the results and findings of this study as a basis for decision making.
- In previous studies the delayed post-test was conducted two to three weeks after the initial treatment (Al Ghafli, 2011:iii; Ben Salem, 2007:ii; Yanguas, 2009:53). For this study the text-specific delayed post-test would have been administered two weeks after the treatment. However, owing to student unrest and complications related to the availability of suitable computer laboratories, these tests could only be administered after eight weeks. The relatively long delay brings an increased risk that longer term retention of vocabulary acquired as a result of the treatment could have been affected by confounding external or extraneous variables. The delay also reduces the comparability of results with results from previous studies.
- During the Group A and C data collection sessions, an issue was encountered with the comprehension test. The test was presented by the VLE, and the HMGs functioned properly, but

some participants from these two groups could not save their answers. Subsequent investigation showed that the issue—now resolved—was caused by the VLE and the pop-up script being written in conflicting versions of javascript. The issue was encountered by Group A on the first day of data collection, and by Group C on the second day. The only speedy resolution available for Group A was to issue participants with A4 feint ruled paper, for them to record their initials, surname, student number and responses manually. By the second day, pre-printed forms could be issued to participants from Group C to capture the same information. This information was subsequently captured and verified through double entry into Microsoft Excel™ by the researcher. Although great care was taken by the researcher to maintain data integrity, it is possible that transcription errors could have occurred due to human error of participants as well as the researcher. While it is not considered likely that such errors would seriously have affected the integrity of data, comparability of comprehension tests between the different groups and within Group A and C may well have been affected. Answering questions on paper might have brought a different load on scarce cognitive resources when compared to answering questions on computer. It is not possible to determine what, if any, effect such a variance in cognitive load could have had on the comprehension scores.

- During the first session of administering the text-specific delayed vocabulary post-test, the computers in the computer lab froze, and tests could not continue. Paper-based answer sheets were then prepared, and data were collected from participants using these answer sheets. Again, great care was taken, through a double-entry verification process, to ensure data integrity, but again there might have been errors in answer coding and decoding by participants and the researcher. Comparability of answers between the computer-based pre-test and immediate post-test and the paper-based delayed post-test may have been compromised as discussed in the previous paragraph.
- Participants might have experienced test anxiety which in turn might have affected the results. There was also a limited amount of time available within which assessments had to be completed. Working fast to finish in time might have led to incorrect answers being provided, such as when a question is not properly read and understood (Heckler, 2011:254). A number of students were not able to complete all the assessments in time, which might have introduced bias into the test results.
- The possible presence of response bias in the process of collecting data and the concomitant effect on test results cannot be ignored. Some responses, such as ratings given in the user experience survey, may have been influenced by what the participants believed the researcher was hoping for.
- Low levels of computer literacy and concomitant anxiety could have hampered the ability of some participants to give an account of vocabulary knowledge and reading comprehension fully representative of the participants' ability. Not being able to control the mouse with dexterity would have made it more difficult to access glosses and select the correct answer in a multiple choice test.

- Allowing user control over gloss access allows students to modify the level of support they receive appropriate to their working memory capacity and their need for support. It, however, also allows them not to access glosses at all. Using group averages might not have been appropriate, as some students might not have used glosses. When using a design with user control over gloss access, the glossing system should have the capacity to track gloss access in detail. It could for example show who accessed which words and gloss elements, how many times, and for how long. Such information would make it possible to analyse the effect of gloss access on vocabulary on an individualised basis, rather than using group averages.
- The estimated means for the immediate text-specific vocabulary post-test were recalculated to adjust for the incomplete answer sets of 23 participants who did not complete the assessment due to time constraints. In one class group, that might have been due to the door to the venue being locked at the time when the test should have commenced, and the research assistant then also not facilitating the session with time limitations in mind. Students started late, and progressed too slowly to complete all the assessments assigned to the experimental group. Adjusting for incomplete answers might have introduced bias, as the reasons for not finishing might have included poor language skills.

6.5 CONSIDERATIONS FOR FACILITATION OF LEARNING

While no practically significant effect of HMGs on vocabulary acquisition and reading comprehension was found, participants still perceived HMGs as useful. They found reading enjoyable when HMGs were present, and expressed a preference for having HMGs available when reading electronic texts. If only for that reason, it is recommended that HMGs be made available in electronic texts where possible.

6.5.1 Considerations for the facilitation of learning in Accounting

Many students encounter Accounting for the first time at university. The subject has its own subject-specific jargon, and being unfamiliar with jargon may be detrimental to understanding Accounting processes and procedures. HMGs have the potential to support the acquisition of jargon, which in turn will facilitate understanding of Accounting processes and procedures. Populating the HMG system with multimedia definitions of terms and illustrations of processes may contribute to making Accounting more easily understandable.

A further application could be to enrich students' contextual frames of reference. Students often have difficulty understanding process cost, for example, because they are unfamiliar with what a manufacturing process is. The cost allocation process, however, follows the manufacturing process, and the absence of an adequate contextual frame of reference hinders understanding of the flow of cost. HMGs present a vehicle for providing that frame of reference through media-rich "nano-lessons". As

gloss access is under user control, the support is provided exactly when, and to the extent in which, the support is required.

6.5.2 Considerations for the facilitation of learning at TUT

What was mentioned in § 6.5.1 is applicable, *mutatis mutandis*, for all courses presented at the university. Furthermore, learning at TUT in general is hampered by the large extent of underdeveloped language skills (Dockrat, 2007:11). Fortunately, the university has invested in providing an institutional VLE, accessible both from within and outside of lecture halls. This provides an ideal platform for rendering electronic support for the development of ELS. HMGs could be one of many tools deployed in the VLE. It provides the opportunity for supporting vocabulary acquisition and reading comprehension, as well as the interaction between vocabulary and reading comprehension. The HMG database could be populated with definitions for at least the 2 000 words used most often in the English language, for words from the Academic Word List and for subject-related jargon. Doing so could allow readers to understand the approximately 95% of words used in a text required to make meaning of that text. At the same time assimilation of vocabulary into the vocabulary, both directly from the glosses and indirectly through incidental learning, is supported (Biemiller, 2001:1; Krashen, 2008:180; Krashen, 2010:47, 55, 57).

6.5.3 Theoretical considerations when provisioning electronic texts with HMGs to support learning

Test anxiety and the perception that one has to finish quickly is often present in test conditions. Where reading takes place in self-paced learning contexts, HMGs might be more beneficial than what can be measured under test conditions. It is, however, recommended that readers be trained in the optimal use of HMGs (Davis & Lyman-Hager, 1997:68; Sakar & Ercetin, 2005:37). Readers should be made aware of their working memory capacity constraints, so that they do not overburden their working memories through excessive gloss access. They should be allowed the opportunity to become familiar with reading from texts and accessing glosses in an electronic environment with the aid of an electronic pointing device such as a mouse. Where possible, time constraints should be removed when academic texts are read, allowing for enough time to make meaning from texts.

While signalling of glossed words can alter gloss access patterns (De Ridder, 2002:135), this should only really be of concern when researching the effect of HMGs. The alternative to signalling glossed words is

to have all words in a text glossed, which is difficult from a practical point of view⁹. Signalling glossed words should help readers avoid trying to access HMGs where glosses are not available for specific words.

Care should be taken when developing glosses to use language which matches the ability of the target audience. Using obscure wording to explain words which a reader does not understand, will not be helpful. Words selected for use in gloss definitions should be more familiar to the potential reader than the word being looked up.

6.6 RECOMMENDATIONS FOR FUTURE RESEARCH

Had this been a study comparing face-to-face delivery to delivery at a distance, its findings could have been considered as a 356th entry into Russell's (2010) comprehensive database of the "no significant difference" phenomenon. Previous studies have, however, indicated significant effect of HMGs on vocabulary and reading comprehension (Chapelle, 2001:71; Liu *et al.*, 2002:260; Lomicka, 1998:41). Findings therefore point instead to the need for further investigation into an approach to implementing and measuring the effect of HMGs which is more suited to the context of this study, and which could replicate the positive effect of HMGs found in those earlier studies.

Evaluating effectiveness of glosses on an estimated group mean score basis is not appropriate where control over gloss access is handed to readers, as gloss access patterns may differ between individual readers. Gloss access behaviour should be tracked on an individualised basis, so that 'before' and 'after' scores can be measured on an individualised basis for those words accessed. To do so would require well-developed gloss access logging functionality in the glossing system.

This study did not find practically significant effects of the pre-test and the interaction of the pre-test on the treatment on vocabulary and reading comprehension scores. The effect sizes, though still small, were slightly elevated, ranging from 0.10 to 0.19 for the vocabulary tests, and from 0.20 to 0.37 for the reading comprehension test. Future studies should consider the pre-test and the interaction effect of the pre-test on the treatment as contributing to the overall effect on vocabulary and reading comprehension scores. A four group experimental design, though difficult to administer, allows for isolating the effect of HMGs from the effect of the pre-test and the interaction effect of the pre-test on the treatment.

Participants perceived the glosses to be useful for vocabulary acquisition and reading comprehension. This perception did not, however, translate into improved estimated mean vocabulary and reading

⁹ This difficulty is more likely to arise in a glossing system which relies on a custom definitions database. A number of browser add-ins are available which allows users to look up textual dictionary definitions in comprehensive online dictionaries for any word displayed in an electronic text accessed via a browser.

comprehension scores. Research is necessary to determine the conditions under which this perceived usefulness would translate into a higher gloss access frequency, and ultimately into improved estimated mean average vocabulary and reading comprehension scores. Where control over gloss access is handed to individual learners, improved individual scores should be the objective.

Previous studies have examined the relationship between frequency of gloss access, time on task and level of reading comprehension (Chun, 2001:367; Knight, 1994:294). In the current study, the comprehension test was imbedded in the reading task. The time taken to complete the comprehension test included both time spent reading the text and time spent answering the comprehension questions. There was no way, however, in which these two time elements could be isolated from each other. gwizz does however have functionality to capture gloss access time. This functionality is being expanded to include capturing access time for each media type. It will then be possible to examine any possible effects of time spent accessing the various media types on vocabulary acquisition and reading comprehension.

In all research, the effect of test anxiety should be considered. Great care should be taken to ensure that participants' response behaviour is not affected by a perceived need to finish quickly. Participants should also be made aware that the test will not have a harmful consequence, for example on academic success, so that the scores achieved are fair reflections of their abilities.

The large variability in research designs hinders comparability and synthesis of research results (Yanguas, 2009:52; Yun, 2011:70). A synchronised approach to investigating the effect of HMGs on vocabulary acquisition and reading comprehension is recommended. Developing a standardised research protocol would eliminate some of the variability in research design, allowing researchers instead to focus on controlling other variables which could influence results.

6.7 IN CLOSING

This study explored the effect of HMGs on vocabulary acquisition and reading comprehension. It also explored the perceived usefulness of HMGs for vocabulary acquisition and reading comprehension, as well as the overall usefulness of HMGs. While users perceived HMGs as useful, this perception was not reflected in a corresponding positive effect on actual vocabulary and reading comprehension scores. Participants in this study did not perceive multimedia elements and first language translations as useful as were expected. The study introduced a four group experimental design as mechanism to isolate the effect of the pre-test and the interaction of the pre-test on the treatment on both vocabulary acquisition and reading comprehension.

EPILOGUE

And as Elijah stood there, the LORD passed by, and a mighty windstorm hit the mountain. It was such a terrible blast that the rocks were torn loose, but the LORD was not in the wind. After the wind there was an earthquake, but the LORD was not in the earthquake. And after the earthquake there was a fire, but the LORD was not in the fire. And after the fire there was the sound of a gentle whisper. When Elijah heard it, he wrapped his face in his cloak and went out and stood at the entrance of the cave.

And a voice said, "What are you doing here, Elijah?"

I Kings 19:11-13

This is one of my favourite passages from the Bible. That, of course, is not the reason why it sprang to mind when my promotor suggested I draft this epilogue. I include the passage for the structure it will lend to this reflection. The passage reminds us of Elijah's calling. It reminds us of his moment of glory on Mount Carmel, and his rude awakening upon realising that this moment of glory made very little difference. Elijah does not find perspective during the raging storm. Instead, when after the storm abates, he takes the time to reflect, meaning comes to him as a quiet whisper. Finally, his passion having been rekindled, his new purpose is revealed.



The early part of my career was spent in Accountancy, first as an articled clerk at an Accounting firm, then as a lecturer. Somewhere in the middle there was even a brief stint in quality assurance at a financial software development company. It was during this period that I had the good fortune of embarking on a master's degree in computer based education. This degree would later allow me to bridge the gap between being an Accounting lecturer, and being an educationalist with a good Accounting knowledge.

I recall being asked once, three months into an introductory Accounting course, what an "asset" was. I realised that, up to that point, the student would have understood nothing of what was happening in class, as she did not understand the meaning of the word "asset". I identified the question as indicative of inappropriate didactics. Henceforth, I would always start such a course by explaining the meaning of "asset", and a few other equally important concepts. On another occasion, a student asked: "Sir, what's an 'average'?" For the first time ever in my teaching career, I did not know how to respond. I identified the question as indicative of an inappropriate career choice. I was "wasting my life", and so I changed my career, becoming instead an instructional designer, serving in a Management Sciences faculty. I should have identified both questions as indicative of underdeveloped vocabularies. I should have realised then already how inseparably interconnected "word meaning" and "learning" are.

Once I started my new career, I was given the challenge to explore how technology and multimedia could be combined effectively to support English language skills development in a multi-lingual context. This challenge led to the development of Esi¹⁰, the precursor to the HMG system used in this study. It was, however, only when I started surveying the literature for this study that I finally came to realise more fully how important vocabulary is to reading comprehension and learning.



The new HMG system, for the moment referred to as gwizz, gained much from both the earlier prototype and the literature survey. Ideally, all words on a page will have some form of glossing available. Gloss access is under user control, meaning users can adapt their gloss access behaviour to their own needs and capabilities. Glosses pop up contiguously to the unknown word, so as not to distract attention away from the text being read. It provides an example sentence, contextual synonyms and meanings of the accessed word which are not appropriate to the context. Access to multimedia elements is optional, and a first language translation of the English word is available for each of the remaining officially recognised South African languages. The glosses attempt to combine text and media elements in a way which will produce a multimedia effect. Previous research shows glossing is effective for supporting vocabulary acquisition, and sometimes also for reading comprehension. This glossing system has everything necessary to support vocabulary acquisition, and perhaps reading comprehension, to a practically significant extent.

Yet it doesn't.



Still, previous studies are rather consistent in finding benefit from glossing. Perspective, I think, should be found not in explaining the results as the failure of HMGs as a notion. Rather, I'll be looking for it in inappropriate data collection procedures and measurement instruments. The last chapter details as many concerns and limitations as I could glean from literature, critical analysis of the results, and reflection on the research process. Here then, for this brief moment, I want to celebrate some of the successes achieved in and through this study.

HMGs, though not showing any practically significant effect on estimated mean vocabulary and reading comprehension scores, were perceived as useful by the participants, and improved their reading

¹⁰ Pronounced "easy", "Esi" is the abbreviation of a Zulu phrase: "Esiyikhulumayo nini na nini", which means "The language we speak".

experience, if not their reading comprehension. That I am busy composing my concluding thoughts of a study which at some point I thought would never be completed, in the words of a certain GOP presidential candidate, is “huge”. That the system was developed by a student from our own university, using nothing but his keyboard, Google and the occasional helpful hint from yours truly—well... It was a student who developed “Esi”. That student is now the CEO of a multi-national IT solutions company. I think we might just have another winner in our current developer. But perhaps the most notable result of this study was in overcoming what was the biggest single challenge during this study—not having the necessary tool to serve the HMGs. We now have such a glossing tool. Although it is still being improved, it is functional, and we can embed in the VLE in use at our university. We have things to research, and we have the tool to research it with. In the meantime, gwizz can already be used in support of our students’ vocabulary acquisition and reading comprehension.



The way forward? The variety in research designs, I believe, is hindering a cogent synthesis of previous research. The highest priority going forward would perhaps be the establishment of a collaborative network, working together to produce such a synthesis, to establish a research agenda, and to develop a commonly used research protocol. Not using the same research design and data collection instruments is likely to introduce rather than reduce variability in results and findings. To that end, gwizz is available to fellow researchers as an Open Educational Resource. As long as we can secure funding, we will continue with its development, focussing on controlling as many as possible independent research variables, and on improving the nature and quality of gloss access tracking.

So that our students’ learning can be facilitated¹¹.

¹¹ **Facilitate**: verb: make (an action or process) easy or easier. From Latin *facilis* ‘easy’

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Could you kindly consider my request and inform me of your decision?

Regards

Gerrit Wissing

Senior Instructional Designer: Teaching & Learning with Technology
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Gerrit-Jan Wissing

From: Tenaglia, Lisa <Lisa.Tenaglia@hbgusa.com>
Sent: 01 July, 2015 9:59 PM
To: Gerrit-Jan Wissing
Subject: Re: Permission to use an image in PhD thesis

Dear Gerrit,

Since you are using the entire page, I can give you permission to use it. If you were to use the images on their own, you'd have to contact Python Productions. The contact I have is Roger Saunders: rsaund1234@aol.com
If you use the entire page, please include a credit line:
Monty Python Flying Circus: Complete and Annotated...All the Bits, 2012, Black Dog & Leventhal Publishers.

Best
Lisa

--

Lisa Tenaglia | Senior Editor | Black Dog & Leventhal/Hachette Books | 1290 Avenue of the Americas | New York, NY 10104
| 212-364-0533 | lisa.tenaglia@hbgusa.com

From: Gerrit-Jan Wissing <WissingG@tut.ac.za>
Date: Wednesday, July 1, 2015 at 12:03 PM
To: Lisa Tenaglia <lisa.tenaglia@hbgusa.com>
Subject: Permission to use an image in PhD thesis

Hi Lisa

I'm attaching the image as "page 4.jpg". It's simply a copy of page 4 of the book, which I want to use exactly as shown in the image.

From what I see in the front matter, you own the copyright over the marginal annotations, but Python Productions own the script, illustrations and photographs. I'm really hoping that I can get permission i.r.o. the latter from you too though, as I have not been able to unearth contact information for Python Productions.

Regards

Gerrit Wissing

Senior Instructional Designer: Teaching & Learning with Technology
Tshwane University of Technology



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From: Tenaglia, Lisa [<mailto:Lisa.Tenaglia@hbgusa.com>]
Sent: 01 July, 2015 5:49 PM
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Subject: FW: Permission to use an image in PhD thesis

Dear Gerrit,

I'm afraid I cannot see which image you are referring to. Could you try sending it to me again?

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Date: Sunday, June 28, 2015 at 1:34 PM
To: Maureen Winter <maureen.winter@hbgusa.com>
Subject: Permission to use an image in PhD thesis

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Regards

Gerrit Wissing

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ANNEXURE C: TEXT-SPECIFIC VOCABULARY TEST

QUESTION 1

procedure means:

- a. the act of searching for something
- b. a process involved in a particular form of work
- c. a public display of group feelings
- d. a favourable judgment

QUESTION 2

creditor means:

- a. a person whose income is above average
- b. a person to whom stray postal mail is forwarded
- c. a person to whom money is owed
- d. a person whose occupation is teaching

QUESTION 3

supply means to:

- a. provide
- b. crowd
- c. exclaim
- d. occasion

QUESTION 4

stationery means:

- a. an affix that is added at the end of the word
- b. writing materials such as pens, paper, and envelopes
- c. compensation paid for damages or money already spent
- d. the ratio of two quantities to be divided

QUESTION 5

frequency means:

- a. the amount of measurable liquid
- b. the number of occurrences within a time period
- c. the amount of weight in pounds
- d. the number of pixels per square inch

QUESTION 6

product means:

- a. tank used for collecting and storing a liquid
- b. an artefact that has been created by someone or some process
- c. a fine cord of twisted fibres used in sewing and weaving
- d. a large artillery gun that is usually on wheels

QUESTION 7

income means:

- a. the basis on which something is grounded
- b. the relative magnitude of an exerted force
- c. payment received in exchange for goods or services rendered
- d. a connection allowing access between persons or places

QUESTION 8

value means:

- a. the starting point for a new experience
- b. the period of time a prisoner is imprisoned
- c. an estimation of intrinsic worth
- d. a delay in the date set for completion

QUESTION 9

journal means:

- a. a likeness in any form
- b. main body of work
- c. daily written record
- d. indirect suggestion

QUESTION 10

annual means:

- a. occurring or returning every year
- b. far more than usual or expected
- c. very strong or vigorous
- d. invulnerable to fear or intimidation

QUESTION 11

enterprise means:

- a. an organization created for business ventures
- b. a crucial stage or turning point in the course of something
- c. the taking possession of something by legal process
- d. a form of government whose head of state is not a monarch

QUESTION 12

telephone means:

- a. signalling mechanism with lights or mechanically moving arms
- b. introduce or insert (oneself) in a subtle manner
- c. restate from one language into another language
- d. electronic device used for conversations over a distance

QUESTION 13

record means:

- a. writing directions for finding some location
- b. capturing information in permanent form
- c. rules of personal conduct
- d. a description of how something is to be done

QUESTION 14

information means:

- a. a collection of facts from which conclusions may be drawn
- b. a tangible symbol signifying approval or distinction
- c. representing an abstract quality or idea as a human
- d. a large number of things or people considered together

QUESTION 15

basis means:

- a. the capacity for rational thought or discrimination
- b. an established system or pattern
- c. a symptom caused by an illness or a drug
- d. a relevant relation or interconnection

QUESTION 16

incur means to:

- a. increase threefold
- b. become liable or subject to
- c. happen simultaneously
- d. sink to a lower level or form a depression

QUESTION 17

transaction means:

- a. something that makes repeated interruptions or divisions
- b. a gradual decrease in magnitude or extent
- c. combining miscellaneous things into a rounded mass
- d. conducting business within or between groups

QUESTION 18

deposit means:

- a. an amount of money placed in a bank or similar institution
- b. animal tissue consisting predominantly of contractile cells
- c. a person of nearly the same age as another
- d. an artefact that has been brought into existence by someone

QUESTION 19

disclose means to:

- a. make previously unknown information available
- b. spend a certain length of time
- c. put out, as of fires, flames, or lights
- d. cause to feel better

QUESTION 20

register means:

- a. a mechanical device by which information is recorded
- b. take something or somebody with oneself somewhere
- c. a facial expression of contempt or scorn
- d. to express a totally negative opinion of

QUESTION 21

manufacture means:

- a. show to be right by providing proof
- b. make bigger or wider in size, volume, or quantity
- c. terminate or abbreviate before the intended or proper end
- d. produce mechanically out of artificial or natural components

QUESTION 22

sufficient means:

- a. brought about or set up or accepted
- b. characterized by painstaking care and detailed examination
- c. a quantity that adequately fulfils a requirement
- d. without formal qualification

QUESTION 23

user means:

- a. an unexpected achiever of success
- b. a contestant that you are matched against
- c. someone who employs or takes advantage of something
- d. someone devoted to the promotion of welfare and reform

QUESTION 24

replace means to:

- a. fasten with or as if with a brooch
- b. benefit by conducting business an exploitative manner
- c. publicly state one's personal convictions
- d. put something in the place of something else

QUESTION 25

purchase means:

- a. something left after other parts have been taken away
- b. government income due to taxation
- c. a homogeneous mixture of two or more substances
- d. the acquisition of something by buying

QUESTION 26

comparable means:

- a. allowing for similarities and differences to be observed
- b. manifesting or subjected to forceful prevention
- c. belonging to or lasting from times long ago
- d. of or relating to or employed in social ceremonies

QUESTION 27

computer means:

- a. housing that someone is living in
- b. an antiquity that has survived from the distant past
- c. a means used to soften the tone of a musical instrument
- d. a machine for performing calculations automatically

QUESTION 28

example means:

- a. a medical procedure involving an incision with instruments
- b. a representative instance serving as illustration
- c. group action in opposition to those in power
- d. being against something that you disapprove or disagree with

QUESTION 29

application means:

- a. the act of liberating someone or something
- b. a substance that can be consumed to produce energy
- c. the act of putting something into operation
- d. a meal that is well prepared and greatly enjoyed

QUESTION 30

equipment means:

- a. drain
- b. output
- c. apparatus
- d. arena

QUESTION 31

additional means:

- a. pertaining to or characteristic of drama
- b. having partial rights and privileges or subordinate status
- c. not keenly felt
- d. further or extra

QUESTION 32

variable means:

- a. a quantity that can assume any of a set of values
- b. a natural inclination
- c. an impressive or wonderful example of a particular quality
- d. the ideal in terms of which something can be judged

QUESTION 33

capital means:

- a. wealth owned by a person or employed in a business
- b. the boundary of a specific area
- c. the outermost level of the land or sea
- d. the point where three areas or surfaces meet or intersect

QUESTION 34

debit means:

- a. an ancient wedge-shaped script used in Mesopotamia
- b. an accounting entry to the left side of an account
- c. a statement that cleverly avoids an unpleasant truth
- d. an organized body of related information

QUESTION 35**receipt** means:

- a. a list of financial assets held by a person or institution
- b. **an acknowledgment that payment has been made**
- c. a statement added to a proposal or document
- d. information that can be used to support an idea or theory

QUESTION 36**deteriorate** means to:

- a. **become worse or disintegrate**
- b. import or export without paying customs duties
- c. be at variance with
- d. smile affectedly or derisively

QUESTION 37**decision** means:

- a. **a position or opinion reached after consideration**
- b. the ability to form mental images of things or events
- c. the latest and most admired style in clothes and behaviour
- d. accumulated knowledge or erudition or enlightenment

QUESTION 38**contribution** means:

- a. a solution obtained by steeping or soaking a substance
- b. any possession that is highly valued by its owner
- c. **a voluntary gift made to some worthwhile cause**
- d. the sum charged for riding in a public conveyance

QUESTION 39**inventory** means:

- a. extra weight
- b. removal and replacement
- c. **stock of goods**
- d. window dressing

QUESTION 40**prime** means:

- a. **first**
- b. swift
- c. desperate
- d. annual

QUESTION 41**document** means:

- a. a slight indication
- b. a word picture of a person's appearance and character
- c. **paper providing written or printed information**
- d. an interpretation of a text or action

QUESTION 42**comprehensive** means:

- a. lacking in strength or firmness or resilience
- b. harassed by persistent nagging
- c. unrestrained, especially with regard to feelings
- d. **all-inclusive, covering a broad range**

QUESTION 43**insolvent** means:

- a. **unable to meet or discharge financial obligations**
- b. conveying information to the muscles from the CNS
- c. annoyed and irritable
- d. marked by quiet and caution and secrecy

QUESTION 44**outstanding** means:

- a. physically disturbed or set in motion
- b. so surprisingly impressive as to stun or overwhelm
- c. **not yet completed, unresolved, unsettled**
- d. greatly exceeding bounds of reason or moderation

QUESTION 45**concern** means:

- a. an amorous display
- b. **a feeling of worry or care**
- c. a state of nearness in time
- d. a direction of the course

QUESTION 46**current** means:

- a. having come or been brought to a conclusion
- b. psychological rather than physical or tangible in effect
- c. affecting only a restricted part or area of the body
- d. **occurring in or belonging to the present time**

QUESTION 47**electricity** means:

- a. **energy from the flow of charge through a conductor**
- b. a document stating the principles of a political party
- c. a rude expression intended to offend or hurt
- d. an advocate of freedom of thought and speech

QUESTION 48**facility** means:

- a. **a service or convenience that an organization offers**
- b. an enclosure of residences and other building
- c. a sphere on which a map is represented
- d. an upright consisting of the vertical part of a column

QUESTION 49**subsidiary** means:

- a. **functioning in a supporting or secondary capacity**
- b. a writer who reports and analyses events of the day
- c. a person motivated by irrational enthusiasm
- d. a person who does not acknowledge your god

QUESTION 50**profit** means:

- a. conformity with rules or standards
- b. the complex of attributes that characterize an individual
- c. **the excess of revenues over expenditures**
- d. the quality of being uncomplicated

QUESTION 51**wage** means:

- a. inheritance
- b. link
- c. remainder
- d. **salary**

QUESTION 52**concrete** means:

- a. a medium for the expression or achievement of something
- b. a conveyance that transports people or objects
- c. **capable of being perceived by the senses, not abstract**
- d. consisting of a piece of machinery

QUESTION 53**accounting** means:

- a. the procedure of determining something by mathematical or logical methods
- b. the science dealing with the logic of quantity, shape, and arrangement
- c. a system that gives quantitative information about finances
- d. the scientific study of crime, criminal behaviour, and law enforcement

QUESTION 54**ability** means:

- a. a momentary brightness
- b. an incompatibility of dates or events
- c. the property of something that is great in magnitude
- d. the power or capacity to be able to perform

QUESTION 55**extent** means:

- a. the space or degree to which something reaches
- b. an unwanted discomfort
- c. congruity of parts with one another and with the whole
- d. an earnest and insistent necessity

QUESTION 56**successful** means:

- a. possessing a distinctive feature to a heightened degree
- b. having achieved a goal or reached a favourable outcome
- c. showing or having knowledge or understanding or realization
- d. distinguishing something particular or special or unique

QUESTION 57**total** means to:

- a. be in direct physical interaction with something
- b. a whole or complete amount
- c. come near or verge on something
- d. serve as a reason or cause or justification of

QUESTION 58**withdraw** means to:

- a. change something for the better, improve
- b. remove, pull back or move away or backward
- c. overlook or make allowances for, forgive
- d. make out of components, often by improvising

QUESTION 59**financial** means:

- a. befitting or belonging to an emperor or empress
- b. of or relating to the mind
- c. of or relating to jurisprudence
- d. involving matters of a monetary nature

QUESTION 60**entry** means:

- a. a show of military force or preparedness
- b. a middle way between two extremes
- c. acquisition of property by descent or by will
- d. an item inserted in a written record

QUESTION 61**source** means:

- a. a group of people living in a particular local area
- b. the educator who has executive authority for a school
- c. the origin of or person who supplies information
- d. a line or route along which something travels or moves

QUESTION 62**practical** means:

- a. relating to the study or practice of medicine
- b. concerned with actual use or practice
- c. characterized by grandeur
- d. notably out of the ordinary

QUESTION 63**distribution** means:

- a. loud confused noise from many sources
- b. the commercial activity of transporting and selling goods
- c. becoming aware of something via the senses
- d. the social event at which the marriage ceremony is performed

QUESTION 64**salary** means:

- a. valuable goods offered at a special discount
- b. a new word formed by combining two others
- c. the spatial property possessed by things in a straight line
- d. monthly remuneration for services rendered

QUESTION 65**trading** means:

- a. exchanging or giving in exchange for
- b. going forward in unison
- c. registering electronically
- d. making a mathematical calculation or computation

QUESTION 66**relevance** means:

- a. related to another person by blood
- b. a blue or green powder used as a paint pigment
- c. the property of being close together
- d. the relation of something to the matter at hand

QUESTION 67**introduction** means:

- a. general election
- b. legal system
- c. public service
- d. opening statement

QUESTION 68**accumulate** means to:

- a. become active and spew forth lava and rocks
- b. come into existence
- c. thrust oneself in as if by force
- d. get or gather together

QUESTION 69

mention means to:

- a. remark
- b. decrease
- c. possess
- d. imagine

QUESTION 70

bankrupt means:

- a. emotionally expressive
- b. annoying, causing annoyance
- c. unable to pay debts as they come due
- d. experiencing a lot of pain

QUESTION 71

transfer means:

- a. give an positive response to, affirmation
- b. move something from one location to another
- c. the act of bringing something to bear
- d. a customary way of operation or behaviour

QUESTION 72

balance means:

- a. a motorboat with an open deck or a half deck
- b. the difference between the totals of the two sides of an account
- c. a disreputable place of entertainment
- d. an open way for travel or transportation

QUESTION 73

entity means:

- a. that which is perceived to have its own distinct existence
- b. the focus of a news article or electronic media communication
- c. the benefit that is paid out to workers after retirement
- d. that which is part of a larger whole or conglomerate

QUESTION 74

liability means:

- a. the state of being disregarded or forgotten
- b. the state of being excluded
- c. a state of conflict between persons
- d. the state of being legally obliged and responsible

QUESTION 75

expand means to:

- a. become less intense and fade away gradually
- b. break down, literally or metaphorically
- c. go down in value
- d. extend in size, volume, or quantity

ANNEXURE D: READING COMPREHENSION TEST

1. Based on the information provided in the extract above, select the best option to answer the question below.

Why are financial statements useful?

- a. Financial statements report decisions made in order to solve problems.
- b. Financial statements indicate suppliers are able to pay the entity's creditors.
- c. Financial statements provide the information users need for making decisions.
- d. Financial statements indicate solutions to problems.

2. Indicate whether the following statement is **True** or **False**.

The balance of an account can be determined by adding the amounts in the debit and credit column.

- a. True
- b. False

3. Indicate whether the following statement is **True** or **False**.

An account has a positive balance if the total debit balance is less than the total amount in the credit column.

- a. True
- b. False

4. Choose the most appropriate option: The word **thus** indicates

- a. consequence
- b. conclusion
- c. comparison
- d. contrast

5. Which of the following statements are correct?

An account has a debit balance if the total of the amounts on the left side of an account is more than the total of the amounts on the right side.

An account has a debit balance if the total of the amounts on the left side of an account is less than the total of the amounts on the right side.

An account has a credit balance if the total of the amounts on the left side of an account is less than the total of the amounts on the credit side.

An account has a credit balance if the total of the amounts on the right side of an account is more than the total of the amounts on the debit side.

- a. Only 1 is correct.
- b. Only 2 is correct.
- c. 1 and 3 are correct.
- d. 1, 3 and 4 are correct.

6. Indicate whether the following statement is **True** or **False**.

A receipt is an example of a source document.

- a. True
- b. False

7. Indicate whether the following statement is **True** or **False**.

Without a cash register slip, information cannot be recorded on the source document.

- a. True
- b. False

8. Indicate whether the following statement is **True** or **False**.

The source document for recording a cash receipt transaction is named the cash receipts subsidiary ledger.

- a. True
- b. False

9. Choose the best answer from the options below to complete the sentence:

A source document provides evidence of a transaction that is...

- a. unjustified.
- b. circumstantial.
- c. legitimate.
- d. abstract.

10. Which of the following transactions referred to above do not affect Mandu's personal contribution to the business' funds?

- a. Mandu purchases bicycle inventory to the value of R25 000 by cheque.
- b. Mandu deposits R100 000 via an internet transfer.
- c. Mandu contributes his unused home computer to the business.
- d. Mandu withdraws R30 000 by cheque for a deposit on his wife's new BMW.

Reset Selection

11. The bicycle Mandu took as his son's birthday present must be accounted for by:

reducing the shop's inventory
 reducing the shop's bank account
 reducing the owner's capital contribution

- a. Only 1 and 2 are correct.
- b. Only 2 and 3 are correct.
- c. Only 1 and 3 are correct.
- d. 1, 2 and 3 are correct.

12. Which of the items listed in the paragraph above can be described as assets?

Capital balance	(R1 400 000)
Opening inventory	(R120 000)
Bank	(R500 000)
Computer equipment	(R200 000)
Land and Buildings	(R1 180 000)
Accumulated profits	(R600 000)

- a. Only items 1, 2 and 4 are assets.
- b. Only items 2, 3, 4 and 5 are assets.
- c. Only items 2, 3, 5 and 6 are assets.
- d. All the items are assets.

13. What is the main purpose of this passage?

- a. To serve as contextualisation.
- b. To serve as a summary.
- c. To serve as an example.
- d. To serve as an elaboration.

14. Select the best option to complete the following statement correctly:

If someone owes you money, you are...

- a. a debtor
- b. a current asset
- c. a creditor
- d. an enterprise

15. What time allowance is usually given for clients to repay a current liability?

- a. 12 months from the date of purchase.
- b. 12 months after the expiry date.
- c. 12 months after the financial year-end.
- d. 12 months after being granted an overdraft.

16. The phrase "Given the extent of transactions" serves to:

- a. indicate a suggestion or proposal.
- b. indicate a motivation or reason.
- c. indicate a conclusion or inference.
- d. indicate cause or effect.

17. If an enterprise is granted an overdraft facility by a bank, the bank in effect becomes one of the enterprise's:

- a. creditors
- b. enterprises
- c. debtors
- d. owners

18. Indicate whether the following statement is **True** or **False**.

A person or entity who owes an enterprise money is known as a creditor. A creditor is an example of a current liability.

- a. True
- b. False

19. Which one of the following options would be most suitable as a heading to this passage?

- a. Service delivery
- b. Expenses
- c. Income
- d. Cost of sales

20. Indicate whether the following statement is **True** or **False**.

Cost of sales are incurred when the enterprise is sold at a profit.

- a. True
- b. False

21. Based on the information provided in the paragraph, which one of the following statements is true:

- a. Since the financial year-end is changed at least once a year, it may be necessary to submit financial statements annually.
- b. Since a financial year may be shorter than 12 months, the information it contains may not be comparable with the previous years.
- c. Since information contained in the financial statements may not be comparable, the financial year might have to be shortened.
- d. Since financial statements are issued at least once a year, it may be necessary to adjust the financial year-end.

22. The purpose of this paragraph is to:

- a. make suggestions regarding the frequency of financial reporting.
- b. draw conclusions about the frequency of financial reporting.
- c. substantiate an argument on frequency of reporting.
- d. indicate a general rule and an exception to the rule.

23. Select the most appropriate option to complete the sentence:

Based on the paragraph it can be concluded that, when considering historical statements of the past five years...

- a. only those statements covering a 12 month period can be taken into consideration to form a clear comparative picture.
- b. annual statements over a period of five years are not helpful in order to form a clear comparative picture.
- c. all annual statements must be taken into consideration in order to form a clear comparative picture.
- d. only those statements covering more or less than a 12 month period can be taken into consideration to form a clear comparative picture.

24. Indicate whether the following statement is **True** or **False**.

This passage shares the opinion that the enterprise is bankrupt as a result of cash flow problems.

- a. True
- b. False

25. Based on this passage we understand that:

- a. the payment of R49 500 caused the cash position to deteriorate.
- b. the payment of R49 500 caused the company to go bankrupt.
- c. the payment of R49 500 saved the company from bankruptcy.
- d. the payment of R49 500 was insufficient to improve the cash position.

26. This passage suggests that:

- a. transactions can be completed by an entity without notifying the bank.
- b. transactions conducted by the entity are only valid once the bank is informed.
- c. transactions completed by an entity are reported to the bank on a daily basis.
- d. transactions conducted by the bank need to be verified by the entity. Reset Selection

27. According to their own records, a business entity has R1 000 in the bank. They pay a supplier R100 by cheque and account for the transaction in their own records. The supplier has not yet presented the cheque to the bank for payment.

The following statements relate to the information above:

The entity's own records show that they have R900 left in their bank account.

The bank's accounting records show that the entity has R1 000 in their bank account.

Only once the supplier presents the cheque to the bank for payment, the bank will adjust their accounting records to show a balance of R900.

- a. Only 1 is correct.
- b. Only 1 and 2 are correct.
- c. Only 3 is correct.
- d. 1, 2 and 3 are correct.

28. A cheque is classified as outstanding if:

cheque payments have been made by the entity by the end of the month.

cheque payments have been recorded by the entity by the end of the month.

cheque payments have not yet been excluded from banking records by the end of the month.

- a. Only 1 is correct
- b. Only 1 and 2 are correct
- c. Only 2 and 3 are correct
- d. 1, 2 and 3 are correct

29. Indicate whether the following statement is **True** or **False**.

The price of the RX2 will be R300 more than that of the RX1 because the entity needs to sell 30 more RX2 units per month than they do RX1 units.

- a. True
- b. False

30. Indicate whether the following statement is **True** or **False**.

The variable cost related to RX2 is less than that associated with RX1.

- a. True
- b. False

31. Indicate whether the following statement/s is/are correct.

It is estimated that monthly sales of the Model RX1 driver is R60 000 [50 x R1 200]

It is estimated that monthly sales of the Model RX2 driver will be R120 000 [80 x R1 500]

It is estimated that total monthly sales of drivers will be R180 000 [R60 000 + R120 000]

- a. Only 1 is correct
- b. Only 2 is correct
- c. Only 1 and 2 are correct
- d. 1, 2 and 3 are correct

32. How many drivers is the entity planning to sell in total every year?

- a. 80
- b. 130 [50 + 80]
- c. 960 [80 x 12]
- d. 1 560 [130 x 12]

ANNEXURE E: USER EXPERIENCE SURVEY

User experience survey

Student number: _____

Age: _____

Gender: _____

First language: _____

M F

Afrikaans

English

isiNdebele

isiXhosa

isiZulu

Sepedi

Sesotho

Setswana

siSwati

Tshivenda

Xitsonga

Other

If 'Other', please specify: _____

Did you have Economic & Management Sciences (EMS) or Accountancy as a subject at school? Yes No

If you answered 'Yes', please indicate for each year

Grade 8 (EMS)

Grade 9 (EMS)

Grade 10 (Accountancy)

Grade 11 (Accountancy)

Grade 12 (Accountancy)

Please rate the following statements about the pop-up definitions:

[1: Strongly Disagree; 2: Disagree; 3: Neutral; 4: Agree; 5: Strongly Agree]

	1	2	3	4	5
Parts of the pop-up dictionary and learning new words					
1. The English definitions in the pop-up dictionary helped me learn new words.	1	2	3	4	5
2. The example sentences in the pop-up dictionary helped me learn new words.	1	2	3	4	5
3. The words with similar meaning in the pop-up dictionary helped me learn new words.	1	2	3	4	5
4. The explanations of what the word does NOT mean in this sentence in the pop-up dictionary helped me learn new words.	1	2	3	4	5
5. The home language translations in the pop-up dictionary helped me learn new words.	1	2	3	4	5
6. The audio pronunciations in the pop-up dictionary helped me learn new words.	1	2	3	4	5
7. The pictures in the pop-up dictionary helped me learn new words.	1	2	3	4	5
8. The videos & animations in the pop-up dictionary helped me learn new words.	1	2	3	4	5

9. Please indicate the three parts of the pop-up dictionary which were most helpful to you for learning new words.					
• English definitions					
• Example sentences					
• Words with similar meaning					
• Explanations of what the word does NOT mean in this sentence					
• Home language translations					
• Audio pronunciations					
• Pictures					
• Videos & animations					
Parts of the pop-up dictionary and understanding what I read					
10. The English definitions in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
11. The example sentences in the pop-up dictionary helped me learn new words.	1	2	3	4	5
12. The words with similar meaning in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
13. The explanations of what the word does NOT mean in this sentence in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
14. The home language translations in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
15. The audio pronunciations in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
16. The pictures in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
17. The videos & animations in the pop-up dictionary helped me understand what I read.	1	2	3	4	5
18. Please indicate the three parts of the pop-up dictionary which were most helpful to you for understanding what you read.					
• English definitions					
• Example sentences					
• Words with similar meaning					
• Explanations of what the word does NOT mean in this sentence					
• Home language translations					
• Audio pronunciations					
• Pictures					
• Videos & animations					
Overall opinion of pop-up dictionary					
19. The pop-up dictionary helped me to pay attention to what I was reading.	1	2	3	4	5
20. The pop-up dictionary helped me to learn new words.	1	2	3	4	5
21. The pop-up dictionary helped me to understand what I read.	1	2	3	4	5
22. The pop-up dictionary was easy to use.	1	2	3	4	5
23. The pop-up dictionary was clear and understandable.	1	2	3	4	5
24. The pop-up dictionary helped to make reading easy.	1	2	3	4	5
25. The pop-up dictionary helped to make reading enjoyable.	1	2	3	4	5
26. I would like the pop-up dictionary to be available when I read course material on the computer.	1	2	3	4	5

ANNEXURE F: INFORMED CONSENT FORM

Researcher: Gerrit Wissing
Affiliation: PhD student at the North-West University.
Project title: Contextual hypermedia glosses in the facilitation of vocabulary acquisition at higher education level
REC Clearance Ref #: NWU-00061-13-A2

Background

The purpose of this research project is to test the effectiveness of a pop-up multimedia dictionary for increasing vocabulary size and for improving reading comprehension. The data collected during this project will be published in a doctoral thesis, as well as in scholarly research articles published in accredited academic journals. Formal permission for this project has been obtained from the Research Ethics committees of Faculty of Education of NWU, as well as from your programme manager and the dean of your faculty.

Three types of data will be collected from you:

- Your knowledge of specific words used in an academic text book, using a vocabulary size test specifically developed for this purpose
- Your understanding of the meaning of certain passages extracted randomly from an academic text book, using a comprehension test developed specifically for this purpose. Some of you have been selected to receive reading support by way of a pop-up multimedia dictionary, accessed by double-clicking on words that you are unfamiliar with
- Your experience, where applicable, of using the pop-up dictionary

As far as we can foresee, no harm will befall you as a result of your participation in this project. The tests are not part of your academic course, and the results will therefore not have any influence on your academic progress. You take part only because you want to. You have the right to stop at any stage without any penalty or future disadvantage to your studies. You do not even have to provide the reason for your decision to stop. If you do decide to take part - I would really appreciate it if you do - the results will be just between you and the research team consisting of the researcher, the researcher's supervisors and a statistician from NWU - only they will see your results. No one will know from the results who you are, except the researcher. Any information from which you can be identified will be removed or hidden in the final research reports, such as the thesis and journal articles. In fact, your individual results will not be referred to in the research report, other than to show the average gains in vocabulary size and reading comprehension—if any—as a result of using the pop-up dictionary. The study is not a part of your course. The results will therefore not have any influence on your academic progress.

Implied consent

By participating in this test you, you agree that:

- The nature, research actions, benefits and risks of this study have been explained to you, and that you read and understood the information written above.
- You know that the results of the study will be just between you and the research team. Nobody will be able to recognise you from the research report.
- You understand that you are taking part only because you want to.
- You understand that you may at any stage and without being penalised take back your permission or stop taking part in the study.
- You had enough opportunity to ask questions.

Of your own free will you declare yourself prepared to take part in the study, and you grant permission for the results of the tests mentioned above to be used in the research reports related to this study.

For further information or questions you may ask the researcher, the research supervisors or the chairperson of the NWU (Faculty of Education) research ethics committee. Their contact details are:

Researcher	Research Supervisor	Research Co-Supervisor	Chair: NWU Faculty of Education REC	Chair: TUT Central REC
Mr. Gerrit Wissing Tel (Office): +27 (0)12 382-4371 E-Mail: wissingg@tut.ac.za	Prof. Dr. AS Bignaut Tel (Office): +27 (0)16 910-3514 E-Mail: seugnet.bignaut@nwu.ac.za	Dr. K van den Berg Tel (Office): +27 (0)18 299-1554 E-Mail: karien.hattingh@nwu.ac.za	Prof. LW Meyer Tel (Office): +27 (0)18 299-4778 E-mail: lukas.meyer@nwu.ac.za	Dr. WA Hoffmann Tel (Office): +27 (0)12 382-6246 E-mail: hoffmannwa@tut.ac.za

Do you agree to participate in this project?

- ☒ Yes
☐ No

ANNEXURE G: ETHICAL CLEARANCE FROM NORTH WEST UNIVERSITY



NORTH-WEST UNIVERSITY
YUNIBESITHI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: (018) 299-4900
Faks: (018) 299-4910
Web: <http://www.nwu.ac.za>

Institutional Research Ethics Regulatory Committee

Tel +27 18 299 4849
Email Ethics@nwu.ac.za

ETHICS APPROVAL CERTIFICATE OF PROJECT

Based on approval by **Ethics Committee of the Faculty of Education Sciences**, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IRERC) hereby approves your project as indicated below. This implies that the NWU-IRERC grants its permission that, provided the special conditions specified below are met and pending any other authorisation that may be necessary, the project may be initiated, using the ethics number below.

Project title: Contextual hypermedia glosses for facilitating English vocabulary acquisition and reading comprehension at a university of technology

Project Leader: Prof AS Blignaut

Research Team: Mnr G Wissing en Dr K Hatting (van den Berg)

**Ethics
number:**

N	W	U	-	0	0	0	6	1	-	1	3	-	A	2
Institution			Project Number							Year		Status		

Status: S = Submission; R = Re-Submission; P = Provisional Authorisation; A = Authorisation

Approval date: 2013-08-15

Expiry date: 2018-08-14

Category **N/A**

Special conditions of the approval (if any): None

General conditions:

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:

- The project leader (principle investigator) must report in the prescribed format to the NWU-IRERC:
 - annually (or as otherwise requested) on the progress of the project,
 - without any delay in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the NWU-IRERC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date, a new application must be made to the NWU-IRERC and new approval received before or on the expiry date.
- In the interest of ethical responsibility the NWU-IRERC retains the right to:
 - request access to any information or data at any time during the course or after completion of the project,
 - withdraw or postpone approval if:
 - any unethical principles or practices of the project are revealed or suspected,
 - it becomes apparent that any relevant information was withheld from the NWU-IRERC or that information has been false or misrepresented,
 - the required annual report and reporting of adverse events was not done timely and accurately,
 - new institutional rules, national legislation or international conventions deem it necessary.

The IRERC would like to remain at your service as scientist and researcher, and wishes you well with your project. Please do not hesitate to contact the IRERC for any further enquiries or requests for assistance.

Yours sincerely

Prof LA
Du Plessis

Digitally signed by Prof LA Du Plessis
DN: cn=Prof LA Du Plessis, o=North-
West University, ou=Campus Rector,
email=Linda.DuPlessis@nwu.ac.za,
c=ZA
Date: 2016.03.09 09:52:43 +0200

Prof Linda du Plessis

Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)