Technology-enhanced interactive engagement

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1.1 Introduction

A lack of interactive engagement between lecturers and students seems to be a worldwide problem in higher education, especially in some African countries, where student enrolment has greatly increased in recent years, though “massification” (massive increase of student enrolment) in higher education seems to be a global trend as well. Since the end of World War II, demand for access to higher education has increased (Guri-Rosenblit, Sebkova, & Teichler, 2007; Working Group on Higher Education, 2004); in most developed countries, student numbers began to increase rapidly at the end of the 1960s (Beerkens-Soo & Vossensteyn, 2009). In contrast, African higher education institutions began to experience increased demand in the late 1970s and early 1980s (Mohamedbhai, 2008). Mohamedbhai notes that African massification of higher education occurred because primary and secondary education levels developed, resulting in more secondary graduates seeking admission to higher education. In addition, students realised that higher education is central for economic development, further increasing enrolment in African higher institutions.

Globally, massification has numerous consequences for higher education systems. For example, the quality of education may suffer because educational resources are in many cases insufficient. The situation in African countries is critical because most higher education institutions depend on their states for funding. Therefore, government-allocated funds should, but often do not, correspond to the massive increase of student enrolment (Mohamedbhai, 2008), resulting in, for example, inadequate lecture rooms and laboratories. In addition, the noticeable increase in student–lecturer ratios leads to a lack
of individual attention to students (Mohamedbhai, 2008), as well as a lack of interactive engagement. Therefore, lecturers are more likely to choose lecture and examination methods that promote surface learning, instead of selecting interactive engagement methods that encourage deep learning. In this study, the issue of quality education is directly related to interactive engagement with other students and lecturers, because such engagement is how learning is realised.

1.2 Interactive engagement

The current study proposes that technology encourages interactive engagement inside and outside the classroom, and interactive engagement improves students’ learning. However, previous research’s definitions of “interactive engagement” have varied. The term has been used interchangeably with “active learning” and “student engagement.” Active learning is a process whereby students actively engage in higher-order thinking tasks and share ideas with one another during the learning process (Felder, 2009; McKeachie, 2002; Prince, 2004). With student engagement, activities are extended by including a variety of factors, such as involvement in co-curricular activities (Kuh, 2009).

Importantly, both terms highlight the active involvement of students in higher-order thinking tasks and sharing of ideas, which promotes conceptual understanding and ultimately leads to improved academic performance. However, the term “interactive engagement” is more appropriate for the current study, because the word “interactive” denotes the shared relation among students, peers and lecturers during the learning process. Therefore, “interactive engagement” is defined as a process that encourages active student–peer and student–lecturer involvement inside and outside the classroom.

Lecturers strive to use technology to interactively engage students in the learning process because traditional teaching (lecture methods) is often regarded as less effective for twenty-first century students (Moore, Moore, & Fowler, 2005). These students are at ease with multitasking activities and depend to a great extent on technology to communicate and access information (Kennedy, Judd, Churchward, Gray, & Krause, 2008). Therefore, as students build and engage their social world in ways shaped by the
technologies that surround them (Guthrie & Carlin, 2004), lecturers should also adapt (Ahfeldt, Mehtab, & Sellnow, 2005), by adjusting their pedagogical practices (Laurillard, 2008), incorporating educational technologies in the learning process and encouraging interactive engagement in their classrooms. However, Harris, Mishra, and Koehler (2009) caution that some technologies are better suited to certain learning activities and educational situations; therefore, lecturers need to be certain that the technology they select will be appropriate for their courses.

Interactive engagement is realised within specific teaching methods. When lecturers decide to incorporate technology in these methods, it is suggested that they use technology pedagogical content knowledge (TPACK) as a framework (Mishra & Koehler, 2006). This framework requires lecturers to understand pedagogical methods that use technology in constructive ways to deliver the content. The present study makes use of three interactive engagement methods: collaborative learning, self-assessment methods and cooperative group-project learning. Because various technologies are used in these methods, the current study refers to them as technology-enhanced interactive engagement (TEIE) methods, defined here as the various methods designed to support the development of students’ critical thinking and problem-solving skills.

### 1.3 Previous research on interactive engagement methods

Researchers have globally investigated interactive engagement methods, enhanced with educational technologies such as clickers, learning management systems and the web (among others). Though, it is not technology as such but the combination of technology, pedagogy and content knowledge that make these methods effective. For example, in their research, Lavooy and Newlin (2003) investigate the application of computer-mediated communication for web-based and web-enhanced courses. Their findings indicate that computer-mediated communication increases student–student and student–lecturer interaction. Similarly, Madigan and Sirum (2006) explore the impact of educational technology on student learning in undergraduate biology courses in the United States. They discover that by using the web, students can access challenging
activities that enhance their understanding of key biological concepts. In addition, the authors conclude that web technology gives students the opportunity to work outside the classroom on concepts they did not understand in the classroom environment. In an integrated biology class, Madigan and Sirum also develop an assessment strategy in which they use clickers to provide immediate and formative feedback to their students.

Other studies also illustrate the effectiveness of TEIE methods on academic performance in various disciplines such as physics (Hake, 1998, 2007), engineering (Van Dijk, Van den Berg, & Van Keulen, 2001), chemistry (Bunce, Van den Plas, & Havanki, 2006) and computer science (Draper, Cargill, & Cutts, 2002). However, the indirect effects of TEIE methods on academic performance, as well as the interaction effects with other variables, have not been investigated. Therefore, this study contributes to the body of knowledge on TEIE methods by exploring both the indirect and interaction effects of different variables on academic performance.

1.4 Context and the rationale for the study

Higher education institutions in South Africa have undergone various changes as a result of a merger that gave birth to three types of public higher education institutions, namely, universities of technology, traditional universities and comprehensive universities (Sedgwick, 2004). Tshwane University of Technology, where this study was conducted, is an outcome of this restructuring of higher education landscape. It consists of the merged technikons of Northern Gauteng, North West and Pretoria. Before the merger, skills were emphasised in these three institutions rather than academic pedagogy. One of the most critical indicators of an institution’s performance is its ability to improve the quality of student learning (Ewell, 2002; Pascarella, 2001). As a result, after the merger, there was a need for teaching approaches that would enrich these skills by emphasising academic pedagogy to ensure quality education for students—that is, an education that would particularly emphasise student-centred learning and transform students into critical thinkers and problem solvers.
Introduction

In 2005, quality assurance audits focusing on the institutional management of teaching, learning and research were conducted at South African higher education institutions. One of the audit panel’s recommendations for Tshwane University of Technology was to prioritise improvement of quality teaching and learning and ensure that strategies and resources for this purpose existed (The Directorate of Quality Promotion, 2007). Initially, there was disengagement about the educational technologies used in teaching and their impact on student learning at the university; that is, some lecturers were using technology because it was there and was supposed to be used. Therefore, students were still passive because, for example, lecturers were simply replacing traditional lectures with PowerPoint presentations. Furthermore, though lecturers uploaded non-interactive content materials to the Blackboard learning management system for students to access on their own time, in some cases they did so because it was a directive from the faculty Dean rather than their initiative to enhance teaching and learning. As a result, the online course material did not improve students’ learning or even encourage interactive engagement among students; it was similar to the PowerPoints presented in the classroom, and no interactive activities were incorporated in these materials.

Educational technologies have improved interactive engagement, students’ learning and academic performance in other countries (e.g., Australia, the United States, New Zealand). Moreover, without good pedagogy, educational technologies are likely to be ineffective for student learning (Madigan, 2006). Therefore, the Tshwane University of Technology put strategies in place to empower lecturers to use technology for the improvement of teaching and learning. The directorate for Teaching and Learning with Technology and the directorate for Curriculum and Development Support were assigned to ensure that lecturers were empowered in this regard. Various workshops were held, and lecturers were encouraged to share their knowledge and experiences using educational technology in their departmental meetings and to write scholarly articles as well.
1.5 Theoretical background of the study

Technology-enhanced interactive engagement methods constitute an emerging research field in South Africa. As a result, significant research gaps exist. The focus in some institutions is still on the introduction of educational technologies and the possible role of these technologies in improving students’ performance. Little research exists on incorporating technology to encourage interactive engagement and students’ learning. Therefore, the current study seeks to increase theory and awareness of TEIE methods in the South African context.

Figure 1.1 depicts the conceptual notion of this dissertation, namely, TEIE methods mediated by motivation and learning have a positive effect on students’ performance.

![Figure 1.1: Conceptual model](image)

To investigate this conceptual model, I integrated theoretical notions and principles such as constructivism, the comprehensive model of educational effectiveness and Gagne’s instructional theory into this study. The following section explains the variables in the conceptual model and how some of them relate to the theoretical principles integrated in the study.

1.5.1 Interactive engagement methods

For students to learn, new information must be incorporated with previous knowledge in their minds (Bunce et al., 2006). This exercise requires rebuilding students’ existing knowledge structure, which, though the student’s responsibility, can be aided by the
teaching methods used in this study. Chapter 3 examines technology-enhanced collaborative learning method. This method facilitates understanding of engineering concepts, and the results convincingly show an improvement in students’ academic performance. Chapter 4 entails two methods: technology-enhanced self-assessment and collaborative learning (no technology involved). Although students in the self-assessment group outperformed the collaborative learning group, both methods encouraged the development of self-efficacy in students. Last, Chapter 5 demonstrates the use of technology-enhanced cooperative group-project learning, which improved students’ intrinsic motivation and deep learning. In addition, this method gave students an opportunity to create and evaluate products as a team. The three methods are effective in improving students’ team spirit, problem-solving and critical thinking skills through discussions and academic performance.

Furthermore, these methods encouraged attainment of knowledge and other competencies such as communication skills, which benefit students during the learning process and in their future lives (Cahyadi, 2004; Perkins & Saris, 2001). The methods also gave lecturers an indication of how students think and learn (Masikunis, Panayiotidis, & Burke, 2009). Personal discussions with lecturers indicated that they could often determine a student’s thinking skills, the learning approach employed and level of motivation during the interactive engagement sessions. Thus, any TEIE method adopted represents an important determinant of the level of interactive engagement, which ultimately can improve students’ motivation, learning and academic performance.

1.5.2 Technology
For the effective use of any technology, lecturers must understand how it affects students and how it encourages their critical thinking (Schuck & Kearney, 2008). It is thus important that lecturers understand the advantages and restrictions of any given technology so they can choose them appropriately for their courses (Harris et al., 2009). Educational technologies investigated in this dissertation were different and appropriate to each study. For example, the clickers used in the study in Chapter 3 were chosen because there was a need for interactive student–student and student–lecturer engagement in a
classroom environment. During personal observation, I noted that, even shy students, and those reluctant to risk failure benefited from using clickers because they could anonymously submit their preferred options.

Chapter 4’s study involves the Blackboard course management system, which was used productively for self-assessment activities. With this system, students were given additional activities to complete independently. Informative feedback on certain activities was also uploaded in the system so students could revise their work accordingly. In addition, all announcements, discussion activities and students’ questions and comments about course content were posted in a Blackboard discussion forum, so that the specific group could contribute to the discussions.

Chapter 5’s study investigates using Blackboard and Facebook as discussion tools. A lecturer in charge of the course created groups in Blackboard and Facebook, and students were requested to sign up for the group they wanted to join. Chapter 5’s study also involved the Blackberry messenger (BBM; a free instant messaging program for Blackberry-to-Blackberry mobile phones) and WhatsApp messenger (a Smartphone messenger that allows users to communicate without having to pay for short message services) used for discussions during practical sessions.

1.5.3 Motivation
Motivation played an important mediating role in learning and academic performance in this study. In educational settings, students need both cognitive skills and the motivational will to learn and eventually improve their academic performance (Pintrich & Schunk, 2002). However, because students’ motivation can fluctuate depending on the circumstances or environment in which they find themselves, researchers consider it unpredictable and sensitive to the context (Linnenbrink & Pintrich, 2002). A variety of motivational concepts may improve student’s learning and academic performance; in this study, intrinsic motivation and self-efficacy are key concepts.

1.5.3.1 Intrinsic motivation
Intrinsic motivation is defined as “the doing of an activity for its inherent satisfactions rather than for some separable consequence” (Ryan & Deci, 2000, p. 56). It entails a great
deal of determination and effort on the part of an individual student. Students who are intrinsically motivated typically do not require any incentives, as the course of action itself is naturally motivating, and the behaviours are performed willingly even if there is no external pressure of reward attached to it. As indicated previously, motivation is not always stable; therefore, students are not intrinsically motivated to complete every demanding activity (Ryan & Deci, 2000)—only those that interest them. This becomes a challenge to lecturers, because even if they can design challenging and interesting activities, some students might still not be intrinsically motivated and could still have a low level of self-efficacy.

1.5.3.2 Self-efficacy

Researchers have positively related self-efficacy to learning and higher performance levels (Linnenbrink & Pintrich, 2002; Pintrich & Schunk, 2002). It refers to a student’s level of confidence that he or she can successfully perform a specific activity (Bandura, 1997). Students with strong self-efficacy beliefs are more likely to put more effort in their studies to understand the content and improve their academic performance. In addition, Eccles, Wigfield, and Schiefele (1998) argue that students with high self-efficacy levels tend to prefer more challenging courses because they believe that they have the capability to successfully complete the course. In contrast, low self-efficacy beliefs hinder academic performance and eventually create a negative belief of failure (Margolis & McCabe, 2006). Self-efficacy seems to be the central motivational belief for students’ learning and performance; thus, to motivate students to engage in activities and improve their academic performance, lecturers must encourage them to believe that they are capable of doing so.

1.5.4 Learning

Giving students activities that stimulate their critical thinking encourages interactions among them, an effective method to encourage deep learning (Offir, Lev, & Bezalel, 2008). As outlined in the conceptual model (Figure 1.1), students learn to improve academic performance. From a constructivist standpoint, students learn by constructing knowledge.
Though, construction of knowledge depends on what students already know, the kinds of experiences students have and how these experiences are incorporated into students’ knowledge structure (Jonassen, Carr, & Yueh, 1998).

Bruning, Schraw and Ronning (1995) refer to students’ initial knowledge about their courses as domain knowledge. The authors identify three sub-types of knowledge within domain knowledge: declarative knowledge, which is factual; procedural knowledge, which includes various skills such as critical thinking and problem solving; and metacognitive knowledge, which encompasses students’ awareness of what they understand and how they think.

With regard to procedural knowledge, Zirbel (2005) argues that for learning to take place, students should take the following problem-solving skill guidelines into consideration: They must (1) clearly understand the problem at hand, (2) search and incorporate new information into their existing knowledge, (3) reorganise their thoughts as they critically think about the solutions in their own understanding and (4) work toward obtaining an understanding of the new information so that it becomes a building block for future learning. This process leads to deep understanding of the course content, which indicates how well course concepts are represented in students’ minds and connected to one another (Zirbel, 2005).

As indicated above, metacognitive knowledge encompasses students’ awareness of what they understand and how they think. For example, if students realise that they do not understand a specific topic, they will ask their peers or lecturers to clarify it. This concept implies that understanding course content is not only information acquisition and accumulation but also knowledge construction and transformation (Blumenfeld, 1992). In essence, students need to be encouraged to have declarative and procedural knowledge; after these types of knowledge have been achieved, metacognitive knowledge will automatically follow. Therefore, lecturers have a crucial responsibility to assist students to achieve both the declarative and procedural knowledge by designing interactive learning instructions in such a way that the student–student and student–lecturer interaction result in students’ cognitive development.
Introduction

In summary, numerous factors, including knowledge base, interaction, previous experience, compatibility of lecturers’ teaching strategy and student’s learning strategy, determine the way students learn (Cahyadi, 2004; Felder & Silverman, 1988; Ramsden, 1992). Extant research suggests that learning occurs when experience, practice and interaction with the environment lead to new understanding of content and enable students to transfer the new knowledge to new situations.

1.5.5 Academic performance
The key to improving students’ academic performance in higher education lies in intensifying teaching and learning (Strydom, Mentz, & Kuh, 2010), and it is the responsibility of institutional management and lecturers to ensure that strategies are implemented to achieve this goal. The comprehensive model of educational effectiveness (Creemers & Kyriakides, 2006) is relevant and influential to this study because it is based on the assumption that student achievement is influenced on student, classroom, school and context levels. Although the school and context levels are important in influencing students’ performance, the current study focuses exclusively on interactive engagement among students and their lecturers within the classroom—in other words, the classroom and student levels. The study also confirms that these two levels balance each other in influencing students’ academic performance. Specifically, the time students spent on the learning tasks (student level) is influenced by the time scheduled for these activities; in turn, time spent and time scheduled are affected by the TEIE methods the lecturers design (classroom level).

As much as constructivism is preferred and practiced by some lecturers, cognitive approaches will always be incorporated in the learning process through structured activities. For example, Gagné’s instructional theory, which describes nine sets of events that help improve students’ learning (Gagné, Wager, & Rojas, 1981), is compatible with online courses (Hannon et al., 2002). In addition, Brown (2004) states that some computer-based learning packages and self-assessment question types, such as multiple choice and fill in the blank, are based on the principles of Gagné’s model. Moreover, some self-assessment activities are designed in such a way that students must provide the
correct answer before moving to the next question. These findings indicate that, in some cases, learning is still predetermined by repetition.

In addition, behaviourism still has a considerable influence in education. For example, Liu, Qiao, and Liu, (2006) find that most lecturers still use a traditional way of teaching in university settings, despite calls for a paradigm shift to interactive, engagement methods of teaching. Thus, even though the views of learning have changed through learning theories and various factors, such as the introduction of educational technologies, a mixture of new and traditional approaches must be incorporated for students to learn and eventually improve their performance.

1.6  Research questions
The aim of this dissertation is to contribute to the body of knowledge about the effectiveness of TEIE methods, in which higher education students are encouraged to interact with one another and supported to think critically so they can construct their own understanding of the content. Thus, I specified the main research question as follows: How can TEIE methods, mediated by motivation, drive students’ learning and academic performance? To answer this question, I formulated four research sub-questions:

1. How do interactive engagement methods and technology, mediated by intrinsic motivation, relate to interactive engagement and academic performance?

2. What effect could interactive engagement activities using technologies such as clickers have on students’ motivation and performance during lectures as compared with such engagement during more traditional lectures?

3. What impact do interactive engagement methods (self-assessment and collaborative learning)—mediated by self-efficacy, task value, time on task and self-regulation—have on students’ academic performance?

4. Can technology-enhanced, cooperative, group-project learning improve students’ comprehension and performance? If so, how?
1.7 Method

To address the preceding sub-questions, I divided this dissertation into four separate studies: a survey (Chapter 2) and three experimental studies (Chapters 3, 4 and 5). Even though these studies were performed in the same university, the nature of the experiments, perceptions and the number of participants differed in each study. The research consisted of working with actual lecturers and curriculum designers to design constructively aligned courses, as Biggs (1999) recommends. All participants, including the lecturers, completed the consent forms, and ethical clearance was obtained, as specified by the university.

1.7.1 Research design and data collection

Chapter 2 describes the first study, a survey involving 526 participants from three departments (management sciences, engineering and science) in the university. Students who had previously used educational technology in their learning process were targeted. Data were collected through questionnaires administered at different times during the classroom period. Students were requested to complete and submit their responses during their next lecture. Of the 615 questionnaires distributed, 526 (86%) participants completed and submitted their responses.

Chapter 3 details the second study, a pre-/post-test study in which 71 engineering participants were randomly assigned to two groups (experimental and control). Data were collected through questionnaires and tests. The first set of questionnaires was distributed immediately after all students had written the first test, and the same set of questionnaires was handed out again directly after all students had written the second test at the end of six weeks.

Chapter 4 describes another pre-/post-test study in which 158 participants from engineering were randomly assigned to three groups (self-assessment, collaborative and control). Data were collected through questionnaires and two formal tests. The questionnaires were distributed a day before the test to avoid survey fatigue after Chapter 3’s study.
The last study (Chapter 5) is also a pre-/post-test study involving 118 participants from the faculty of engineering. Participants in this study were also randomly divided into the experimental and the control groups. Again, data were collected through questionnaires and tests, distributed a day apart to avoid survey fatigue.

\subsection*{1.7.2 Instruments}
To ensure that prior knowledge of students in the experimental group and control group did not differ significantly, I presented a pre-test on content before the experimental lectures were performed in the three experimental studies (Chapters 3, 4 and 5). The pre- and post-tests in these three studies were designed by the lecturers in charge of the courses. To ensure validity, all the tests were aligned with the learning objective of the course content, and the alignment was verified by the researcher and the curriculum designer.

With regard to the questionnaires, it was convenient to adapt already developed instruments from various researchers because of their reliability and availability. Therefore, I adapted questionnaires on the Motivated Strategies for Learning Questionnaire (MSLQ) from Pintrich, Smith, Garcia, and McKeachie (1991). I adapted technology and interactive engagement questionnaires from Liawm (2008), interactive engagement methods questionnaires from Kaufman, Sutow, and Dunn (1997) and learning approaches from Biggs, Kember, and Leung (2001). I designed questions on time-on-task. Table 1.1 gives an overview of the instruments used for each study.
Table 1.1: Instruments used for each study

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Authors</th>
<th>No. of items</th>
<th>No of options</th>
<th>Maximum score</th>
<th>Chapter 2</th>
<th>Chapter 3</th>
<th>Chapter 4</th>
<th>Chapter 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Liaw (2008)</td>
<td>4</td>
<td>5</td>
<td>20</td>
<td>526</td>
<td></td>
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<tr>
<td>Interactive engagement</td>
<td>Kaufman et al. (1997)</td>
<td>7</td>
<td>5</td>
<td>35</td>
<td>526</td>
<td></td>
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<tr>
<td>Interactive engagement</td>
<td>Kaufman et al. (1997)</td>
<td>4</td>
<td>5</td>
<td>20</td>
<td>526</td>
<td></td>
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<tr>
<td>Deep Learning</td>
<td>Biggs et al. (2001)</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>526</td>
<td></td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>Surface learning</td>
<td>Biggs et al. (2001)</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>526</td>
<td></td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>MSLQ Intrinsic motivation</td>
<td>Pintrich et al. (1991)</td>
<td>4</td>
<td>7</td>
<td>28</td>
<td>526</td>
<td>71</td>
<td></td>
<td>118</td>
</tr>
<tr>
<td>MSLQ Extrinsic motivation</td>
<td>Pintrich et al. (1991)</td>
<td>4</td>
<td>7</td>
<td>28</td>
<td>71</td>
<td></td>
<td>118</td>
<td></td>
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<tr>
<td>MSLQ Test anxiety</td>
<td>Pintrich et al. (1991)</td>
<td>5</td>
<td>7</td>
<td>35</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MSLQ Self-efficacy</td>
<td>Pintrich et al. (1991)</td>
<td>8</td>
<td>7</td>
<td>56</td>
<td></td>
<td></td>
<td>153</td>
<td></td>
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<tr>
<td>MSLQ Task value</td>
<td>Pintrich et al. (1991)</td>
<td>6</td>
<td>7</td>
<td>42</td>
<td></td>
<td></td>
<td>155</td>
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<tr>
<td>MSLQ Self-regulation</td>
<td>Pintrich et al. (1991)</td>
<td>12</td>
<td>7</td>
<td>84</td>
<td></td>
<td></td>
<td>156</td>
<td></td>
</tr>
<tr>
<td>MSLQ Peer learning</td>
<td>Pintrich et al. (1991)</td>
<td>3</td>
<td>7</td>
<td>21</td>
<td></td>
<td></td>
<td>118</td>
<td></td>
</tr>
<tr>
<td>MSLQ Help seeking</td>
<td>Pintrich et al. (1991)</td>
<td>4</td>
<td>7</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td>118</td>
</tr>
<tr>
<td>Time on Task: studytime</td>
<td></td>
<td>1</td>
<td>5</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>158</td>
</tr>
<tr>
<td>Time on Task: attendance</td>
<td></td>
<td>1</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td>158</td>
</tr>
</tbody>
</table>
Chapter 1

According to Strydom et al. (2010), the reliability of a measure reveals the degree to which an instrument yields similar results in various settings and over various time frames. Therefore, I determined the reliability of the instruments used in this dissertation with a statistical analysis program, SPSS; all instruments were found to be reliable (see Chapters 2–5).

1.7.3 Data analysis methods
Quantitative designs have various methods for analysing data, from which I chose three that were suitable for this study: analysis of covariance (ANCOVA), the t-tests and structural equation modelling. The following paragraphs present a brief explanation of how I used these analysis methods.

In Chapter 2, I used LISREL 8.8 (Jöreskog & Sörbom, 2006), a statistical software package that supports structural equation modelling, to explore the relationships between the variables. The analysis began with the calculation of the relationships among all the variables in the model concurrently with interactive engagement methods and technology as independent variables. Interactive engagement and performance were included as dependent variables in the model, and intrinsic motivation and deep learning were included as mediating variables.

In Chapter 3, I conducted ANCOVA to test for statistically significant associations between the independent variables and the dependent variable, taking the effects of the covariates into account. I tested five models: Model 0, to test for the significance of the difference between the experimental and control group, as well as the pre-test Model 1, covariate Model 2, content Model 3 and interaction effect Model 4.

I also performed ANCOVA in Chapter 4 to measure the effect of interactive engagement on students’ motivation and performance. I tested four models: the treatment model, in which the effect of the treatment, namely the interactive engagement activities, was measured; the pre-test model, in which I included the pre-test score; the covariate model, in which individual backgrounds of participants were added; and the motivation model, in which I measured the relationship between the groups and
their motivational levels to determine whether a relationship existed between motivation and the dependent variable.

Chapter 5 incorporates three analysis methods. First, I wanted to determine whether there was any difference between the experimental and control groups on post-test performance using analysis of variance. Second, I performed t-tests to determine the difference between all variables in experimental and the control groups. Third, I used LISREL 9.1 (Jöreskog & Sörbom, 2012) to analyse the data. Specifically, I used the multiple-comparison group method to determine whether technology-enhanced cooperative group-project learning (TECGPL) made any difference between the groups.

1.8 Outline of the dissertation

This dissertation begins by exploring factors that contribute to interactive engagement and performance. I propose that technology complements interactive engagement methods and vice versa. Therefore, I designed my studies to determine whether this is the case. The following paragraphs briefly outline the remainder of the dissertation.

Chapter 1 introduces this dissertation, the rationale and theoretical background of the study. It also presents an overview of the study.

Chapter 2 details a study exploring the relationships between factors that contribute to higher levels of interactive engagement and performance such as, interactive engagement methods, technology, motivation, and deep learning. This chapter serves as the base of this dissertation, because it links the lecturer’s style of teaching with students’ approaches to learning. The findings provide a source of inspiration for further research on integrating educational technologies with interactive engagement methods such as collaborative learning, self-assessment and cooperative group-project learning. Table 1.2 illustrates the type of teaching method and technology used in each experiment.
Chapter 1

Table 1.2: Teaching method and technology used in each experiment

<table>
<thead>
<tr>
<th></th>
<th>Chapter 3 Experiment 1</th>
<th>Chapter 4 Experiment 2</th>
<th>Chapter 4 Experiment 3</th>
<th>Chapter 5 Experiment 4</th>
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<tbody>
<tr>
<td><strong>Teaching method</strong></td>
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<td>Lecture</td>
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<td>Individual assessment and feedback</td>
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<td>Lab work</td>
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<td>Group-project learning</td>
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<tr>
<td><strong>Technology used</strong></td>
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<td>Clickers</td>
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<tr>
<td>Facebook</td>
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<td>Mobile phones</td>
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Chapter 3 presents a study that investigates the effect of interactive engagement activities using clicker technologies on students’ motivation and performance during lectures. Even though educational technology (clickers) was incorporated in this study, the importance of educational pedagogy was emphasised more than the technology used. This chapter also emphasises that more adequate instruction motivates students to learn, which in turn leads to improved performance. The results confirm Hake’s (1998) claim that students who attended a course that used clickers scored higher on the post-instruction exam than did those from classes that did not use clickers.

Chapter 4 describes the impact of two specific interactive engagement methods (self-assessment and collaborative learning) on students’ academic performance. It also investigates whether these effects are mediated by self-efficacy, task value, time spent on the task and self-regulation. The Blackboard course management system was used as the educational technology to deliver self-assessment activities and serve as a communication
Introduction

...tool in the self-assessment method whereas no technology was used for collaborative learning.

Chapter 5 presents an exploration of the extent to which technology-enhanced cooperative group-project learning can improve students’ learning and performance. I investigated technology-enhanced cooperative group-project learning as a possible interactive engagement method for improving students’ learning and performance. Students were given a group project in which they were expected to study and understand how the structure of the material changes due to heat. They used a variety of technologies, such as Blackboard, Facebook and mobile phones (among others) to facilitate communication during the learning process.

Chapter 6 presents a summary of the results and an evaluation of the conceptual model.

Chapter 7 presents the general discussion including the use of Technology in African higher education institutions. It also presents a discussion of practical implications. The chapter concludes with a discussion of the study’s limitations and suggestions for further research.

In summary, this chapter provides an overview of the dissertation. It highlights the underlying rationale for doing this research. Most important, it emphasises the importance of incorporating technology in the learning process. However, it must be stated that learning is an active process, and technology can provide a wide range of active learning opportunities, such as accessing rich information and reaching other many students simultaneously. Therefore, lecturers should not hope for improved learning outcomes if they do not adjust their pedagogical approach; incorporating technology in the learning process without changing pedagogy will not make any difference in students’ learning.