7.1 Introduction
Research shows that interactive engagement improves students’ learning and academic performance (Bernhard, 2000; Mazur, 2009). In the context of this study, “interactive engagement” is defined as an activity that promotes student–student and student–lecturer interaction inside and outside the classroom. However, the trend of massive enrolment of students in higher institutions worldwide indicates that a lack of interactive engagement is still a global phenomenon in higher education. In many cases, lecturers remain the centre of attention and do not incorporate interactive activities in their lessons to encourage student interaction. Technology-enhanced interactive engagement (TEIE) methods can facilitate interactive engagement among students; however, many lecturers who incorporate technology may not notice the impact unless they change their teaching methods as well.

7.2 Does technology have a place in education?
Sandholtz, Ringstaff, and Dwyer (1997) suggest that if implemented properly, technology has the potential to transform education in a valuable way. Higher education research has pointed to the value of technology as a tool for teaching and learning for decades (Peled, 2000). As a result, the increase in the availability of educational technologies in higher education makes it imperative for lecturers to integrate technology into their teaching methods.

Not all researchers agree that technology is a valuable tool in education. For example, Clark (1983, p. 450) states that “there are no benefits to be gained from employing different media in instruction”; this finding suggests that if a course can be
delivered without technology, there is no need to implement it (Technology). However, the results of the studies conducted in this dissertation indicate that whether technology makes a difference depends entirely on which technology is used and how. Thus, lecturers need to be creative, formulate strategies and use suitable technologies for their courses. They must also need to keep in mind what they want to achieve with the chosen technology.

The results of this study reveal that in addition to encouraging students’ interactive engagement, technology can be used to improve other educational factors. For example, the direct effect of technology on motivation (Chapter 2) implied that technology motivated students to employ deep learning strategies. Similarly, the absence of a direct effect of technology on deep learning emphasised that technology did not on its own improve students’ learning in this study; for technology to have a positive impact on learning, students had to become motivated to learn and interactively participate in the discussions with other students and lecturers. As indicated in Chapter 1, uploading content in the Blackboard learning management system without any interactive activities did not motivate the students. As a result, many of them did not improve their learning. Those who improved their performance were either self-motivated or, more likely, had memorised the content. The results of this study specify the primacy of educational factors over the technology factors (Chapter 2). However, they also show that the effect of educational factors can become stronger when technology is incorporated. Basically, technology played an important role in increasing the effectiveness of educational factors.

Because students’ pass rate is of concern in many South African higher institutions, the finding that using technology encouraged students to learn and ultimately improved their performance is significant. Although the direct effect of technology on academic performance (Chapter 2) is important, the finding that the indirect effects of technology through educational factors (motivation and deep learning) had more impact on students’ academic performance than technology is even more so. These results emphasise that technology enhances educational factors to improve students’ learning and performance. Furthermore, it facilitated teaching for the lecturer by reducing the pressures of large numbers of students in the course: it was much easier for lecturers to
assess students’ comprehension through the Blackboard learning management system, which automatically marked the assessments and provided students with informative feedback.

7.3 Technology and interactive engagement

Interacting with others provides continuous learning opportunities and inspires personal and professional growth (Oblinger & Hawkins, 2006), implying that learning is realised through interaction and support from people with more knowledge on the subject. Although some authors argue that technology has been used mainly to replace face-to-face teaching (Hedberg, 2006), the current study shows that technology can actually improve interactive engagement in education. Furthermore, I also noted that using technology inside and outside a classroom is engaging, because it compels interaction among students and between students and lecturers, in line with previous research (Damoense, 2003; Gautreau, 2011; Lavooy & Newlin, 2003; Perkins & Turpen, 2009) that has demonstrated that these technologies are effective tools for engaging students interactively if selected appropriately.

The results in the present study reveal a direct effect of technology on interactive engagement, which suggests that various technologies encouraged students to interact with one another and their lecturers. This is not surprising, as many students use smartphones, laptops and tablet computers; as such, they are likely to be technologically advanced, collaborative and team-oriented. To accommodate these students, lecturers need to be creative and find ways to incorporate various technologies in the curriculum. Some of the technologies used in this study, such as the Blackboard discussion tool, Facebook and WhatsApp, facilitated real-time, synchronous collaboration even outside classroom settings. In addition, clickers tested students’ understanding of the content and encouraged participation in the classroom.

Through motivation, we observed the indirect effects of technology on interactive engagement, which implies that technology also motivated students to interact and be constructive in their discussions rather than passive or competitive during the learning
process. Because they were motivated to interact with one another, they voluntarily used their mobile phones and included Blackberry messenger (BBM), Facebook and WhatsApp messenger as additional discussion tools (see Chapter 5). Moreover, because these tools reduced reliance on access to computers and stable Internet connectivity for discussions, students and lecturers were able to share information and opinions anytime and anywhere. Thus, I conclude that, combined with well-designed courses, technology can be used to create interactive engagement in a classroom.

7.4 The use of technology in African higher education institutions

The mass demand for higher education exerts a great deal of pressure for institutions to provide high-quality higher education. Massive increases in student enrolment have negatively affected education quality. Other negative effects include inequality among students and institutions, insufficient access to higher education, inadequate human resources and insufficient funds. However, various researchers (Adam, 2003; Garrison & Anderson, 2003) have argued that new technologies, as well as the innovative use of old ones, are helpful in addressing some of these challenges. The results of this study also suggest that the use of technology in education enhances and improves the quality of teaching and learning.

African higher institutions have adopted several strategies to cope with massification, including (1) using technology in management and teaching and (2) training lecturers on the use of technology in education to deal with large numbers of students. However, many African higher institutions, including those with reasonably good technology infrastructure, are still at the nascent stage of incorporating technology into teaching and learning because few lecturers have adequate technological experience. During personal conversations with lecturers at Tshwane University of Technology, I noted that lack of experience in teaching with technology was their main concern, and they indicated that they needed training and departmental support in this regard.

In South Africa, many higher learning institutions have dedicated considerable resources for technology integration in the classrooms (Moll, Adam, Backhouse, & Mhlanga, 2007), an important initiative in reducing the inequalities among universities in
the country and increasing education quality. Thus, many South African students have now begun to see more equal opportunities inside and outside the classroom. Many students, especially in South Africa, enter higher institutions unprepared because of inequitable curriculum among primary, secondary and high schools. For example, these students might lack relevant skills needed for certain courses such as mathematics. They are typically advised to register for courses that offer extra support to address underprovided skills. To address such undersupplied skills, lecturers in one of the South African institutions used interactive spreadsheets in the form of tutorials to develop prospective students’ mathematical literacy skills. These tutorials were used in combination with face-to-face lectures and included interactive presentation of mathematics content, related examples and activities. Students received immediate informative feedback while working on these activities. Frith, Jaftha, and Prince (2004, p. 163) indicate that “while the lecture room tutorial taught students how to calculate the various statistics, the computer tutorial was more effective in giving them an understanding of the concepts and they retained better what they had learned.”

In addition, technology is effective in supporting education by providing e-assessment. Using learning management systems such as Blackboard to deliver tests and examinations helps lecturers successfully to cope with large numbers of students, thereby improving the quality of learning as lecturers provide informative feedback in the system. Thus, if there are no open-ended answers, students get their results immediately after submitting their examination and have the opportunity to correct their mistakes through informative feedback designed by the lecturer. These learning management systems offer various types of questions, which, if designed properly, could cover all levels of cognitive domains, from recalling information to evaluating an idea or a product. Although some universities have familiarised themselves with using technology for assessing students, many lecturers need more training in designing technology-enhanced higher-order thinking questions.

Certainly, training lecturers on integrating technology, pedagogy and content is the most basic and imperative step toward improving education quality. In addition,
support and buy-in from the deans and heads of the departments is necessary so that technology infrastructure is in place. Technology reduced the pressure of large enrolment in specific courses; it also improved students’ learning and performance in this study. Furthermore, students felt at ease using technology; they experienced freedom of expression (e.g., students could submit their answers anonymously through clickers, as described in Chapter 3). Furthermore, they had access to variety of learning material. Last, they learned from one another and developed various skills such as critical thinking and working as a team.

An observation of the trends of massification in higher education in Africa indicates that the demand for higher education will continue to increase over the next decade. Therefore, technology will become more important in higher education because of not only its effectiveness but also its efficiency, in the sense that lecturers can simultaneously deliver lectures to interrelated classrooms through videoconferencing. Moreover, new technologies are being introduced continuously in education. There is no turning back; technology is here to stay.

7.5 Practical implications

The outcomes presented in this dissertation generally support the claim that using TEIE methods in education is beneficial for students’ learning and academic performance. Thus, educational technology has a key role to play in higher education; it could be used as a strategy for addressing teaching and learning concerns. As a result, policy makers and institutions must take additional actions to support implementation of educational technology in higher education.

Although deans are quick to urge lecturers to use technology, they may not realise the difficulties that lecturers experience in implementing it. The current study demonstrates that teaching with technology is not as easy as many people might think; it requires a change in the lecturer’s method of teaching. That is, to successfully teach with technology, lecturers need to have knowledge of the technology they want to use, the method to be used and the content to be taught. In addition, a large amount of
administrative work must be done before technology can be used in the classroom. For example, the content material used in these studies had to be redesigned to suit the technological environment, and lecturers had to be supported until they were ready to teach with technology on their own.

Therefore, institutions need to emphasise regular lecturer training on pedagogic integration of technology into higher education courses and provide regular technical support as well, until lecturers are confident enough to continue on their own. Lecturers cannot implement technology without help from experts; however, if they receive appropriate training, they gain more knowledge on how to successfully manage their classrooms. In addition, they can confidently use technology to create a more interesting learning environment while their pedagogic and technical knowledge contributes more to students’ motivation, learning and academic performance.

Previous research has shown the importance of intrinsic motivation during the learning process. Intrinsically motivated students are more likely to engage in deep-level study strategies and achieve better academic performance (Baker, 2004). However, the findings of this study go further to demonstrate that peer learning has a stronger impact on deep learning and students’ academic performance than motivation does (Figure 5.4). Therefore, lecturers should not overlook the importance of peer learning for improving students’ deep learning and academic performance. Furthermore, lecturers need to monitor the process of peer learning, as it entails support and scaffolding from more knowledgeable students, who also need encouragement from lecturers.

The current study’s findings reveal that deep learning had a stronger impact on academic performance than other variables in the study (Figure 2.2 and Figure 5.4), important results every lecturer hopes to achieve. However, lecturers must realise that they are responsible for developing and enhancing students’ deep learning skills. In my view, lecturers can create and stimulate deep learning when they use social constructivist learning principles. That is, students should be encouraged to work in groups to develop their interactive engagement skills. In addition, creating activities that resemble authentic situations can help develop students’ deep learning approaches. Thus, lecturers should
design activities that are similar to problems that students will be facing in their employment. This will increase students’ intrinsic motivation and encourage them to think critically, simulating an actual work situation.

### 7.6 Limitations and suggestions for future research

This study has limitations. First, the majority of the participants in this study were from the faculty of engineering, with a few students from the faculty of science and faculty management sciences. Although Blackboard learning management system and clickers are the commonly used technologies at the university, other faculties are also using other types of technologies. Not including these other types of technologies may have biased the results toward the faculty of engineering students and precludes the generalisation of the results to the entire population of Tshwane University of Technology and higher education students worldwide. Although engineering students are not inherently different from other students, attempts should be made to replicate this study and include more students from other faculties to increase the generalisability of the outcomes presented in this study.

Second, the duration of the experiment was short. For example, when the clicker model (Chapter 3) was compared with Gagné’s instructional events, retention and transfer of learning over a long period of time could not be accounted for because of the duration of the experiments. It cannot be confirmed that a six-week learning period would enable students to retain and transfer what they have learned to their employment. Therefore, a longitudinal study (three years or longer) of students’ retention and transfer of learning would increase the strength of the claims of this study.

Third, the data in the present research were analysed quantitatively. However, during personal conversation with some of the students, I realised that this study could have been enhanced and enriched by qualitative research aspects as well, to improve understanding of complex issues that could not be explained through quantitative analysis. For example, the negative effect of TEIE methods on academic performance (Chapter 2) could have been better explained qualitatively if students were given an opportunity to express their opinions through open-ended questions or semi-structured
interviews. Therefore, the current study could be expanded further through a mixed-method research in which students could express their opinion about situations difficult to explain quantitatively.

In conclusion, this dissertation contributes to literature on TEIE methods by exploring both the indirect and interaction effects of different variables on learning and academic performance. Specifically, the study depicts peer learning as one of the main mediators of TEIE on deep learning and academic performance. Deep learning also played an important role by mediating most of the variables in the study on academic performance. Overall, this study explains the learning process: When lecturers use a variety of TEIE methods in well-designed courses that include higher-order interactive activities, students become motivated to interact with one another inside and outside the classroom, which in turn leads to deeper understanding of the course content and encourages students to connect concepts within content material and ultimately improve their academic performance. Although this study was conducted in a higher education setting in South Africa, which represents a setting rarely investigated in prior research; the results should have implications in broader higher education settings as well.