Technology-enhanced interactive engagement
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Chapter 6
Summary

6.1 Introduction
The aim of this dissertation is to contribute to knowledge about the effectiveness of TEIE methods, in which higher education students are motivated to interact with one another and supported to think critically in constructing their own understanding of the content to learn and ultimately improve their academic performance. Thus, the main research question is as follows: How can TEIE methods, mediated by motivation, drive students’ learning and academic performance? To answer this main question, I formulated four sub-questions. First, I investigated factors that would encourage a higher level of interactive engagement and performance, such that I formulated the first question as follows: How do interactive engagement methods and technology, mediated by intrinsic motivation, relate to interactive engagement and academic performance? Next, I investigated incrementally deeper levels of interactive engagement, from collaborative learning using clickers to cooperative group-project learning using a variety of technologies, and posed the remaining three questions:

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?

This dissertation addresses these sub-questions according to different levels of interactive engagement using four separate studies.


6.2 Design

Chapter 2 is a survey, and Chapters 3, 4 and 5 are experimental studies conducted at Tshwane University of Technology in South Africa. This university is one of the many that have long been striving toward improving the quality of teaching and learning in difficult circumstances, including lack of resources, massive enrolment of students and low student pass rates. Many students were invited to participate in the study. Although these four studies were conducted in the same university, the nature of the experiments and the number and views of participants differed in each study. Overall, 873 students participated in this study; data were collected through class tests designed by participating lecturers and through previously developed questionnaires adopted from various researchers. Two sets of questionnaires (pre- and post-test) were distributed in the classrooms for each study. The first sets of questionnaires were distributed at the beginning of each study either before or immediately after the first class tests (pre-test) were taken. The second sets of questionnaires were distributed before or after the second class tests (post-test) were taken. I used structural equation modelling in Chapters 2 and 5 and analyses of covariance in Chapters 3 and 4 to analyse the data.

6.3 Summary of results

To address the sub-questions in 6.1, I formulated hypotheses for each question and tested them in Chapters 2–5. The following sections summarise the results of these studies.

6.3.1 Exploring the relationship between factors that contribute to interactive engagement and academic performance

Chapter 2 explores the relationship between factors that influence the attainment of a high level of interactive engagement and improved performance. Because researchers maintain that motivation is the main factor in attaining high levels of interactive engagement and academic performance, I used it as a central mediating variable in this study. Therefore, I specified the research question as follows: How do interactive
engagement methods, and technology, mediated by intrinsic motivation, relate to interactive engagement and academic performance?

The results of structural equation modelling reveal that both interactive engagement methods and technology improve students’ interactive engagement. However, the direct effects of educational factors (interactive engagement methods, motivation and interactive engagement) had more impact on students’ learning than technology did. In addition, I observed an indirect effect of interactive engagement on academic performance through deep learning. Deep learning played an important role in mediating the effects of interactive engagement methods, technology, intrinsic motivation and interactive engagement on academic performance (Figure 2.2). In line with these findings, I conclude that this study offers a convincing demonstration that through motivation and deep learning, interactive engagement methods and technology complement each other with regard to interactive engagement and performance.

6.3.2 Using clickers to facilitate interactive engagement activities in a lecture room for improved performance by students

Chapter 3’s study investigates the effect of interactive engagement activities using clicker technologies on students’ motivation and performance during lectures. The central research question is as follows: 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?

An analysis of covariance showed a significant difference between the TEIE method and the traditional type of lecturer groups, even after including pre-test scores. Native language revealed a significant effect on performance; students whose native language is English outperformed students with English as their second language. I observed no relationship between motivation and students’ performance; that is, intrinsic motivation, extrinsic motivation and test anxiety were not significant. These results indicate that the experimental effects were strong: Even after taking into account the pre-test, covariates and diverse motivational variables, the experimental effect of TEIE activities remained highly significant.
6.3.3 The impact of interactive engagement methods on students’ academic achievement

Chapter 4 describes the impact of two specific interactive engagement methods (self-assessment and collaborative learning) on students’ academic performance. It also explains whether these effects are mediated by self-efficacy, task value, time spent on the task and self-regulation. The research question addressed in this chapter is as follows: 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?

The analysis of covariance results reveal that interactive engagement methods have positive effects on students’ academic performance, consistent with previous studies (Hake, 1998). In addition, I observed a significant interaction of self-efficacy and self-regulation, suggesting that the level at which students regulated their learning exerted different effects on academic performance, depending on students’ self-efficacy. Self-regulation was not a notable main effect in this study, but it had an influence when combined with self-efficacy. Furthermore, the combination of self-regulation and time spent on the task revealed a weak but significant interaction, likely due to the sample size restriction. These results indicate that the impact of interactive engagement methods (especially TEIE) on academic performance remain significant across the groups, even when moderated by independent variables. Using TEIE methods improved the academic achievement of students. Self-efficacy, task-value and time on task could improve academic achievement even more. For the lecturer this means they should design inspiring tasks that increase the self-efficacy of students, and give opportunities for peer-learning. It is up to the student to work on their self-efficacy, self-regulation, which leads to higher academic achievement.
6.3.4 Using technology-enhanced cooperative group-project learning for student' learning and academic performance

Chapter 5 examines the impact of technology-enhanced, cooperative, group-project learning on students’ learning and academic performance. The research question addressed in this study is as follows: Can technology-enhanced, cooperative, group-project learning improve students’ comprehension and performance? If so, how?

The analysis of variance showed a significant difference between the experimental and control groups. Peer learning is the dominant factor in the final model. In addition, the results of structural equation modelling revealed that peer learning had a direct effect on academic performance in both the experimental group and the control group. The results also indicate that the indirect effect of peer learning on academic performance through intrinsic motivation was absent in the control group. Furthermore, the indirect effect of peer learning on academic performance through deep learning was present in both the experimental group and the control group. Last, seeking help had no effect on academic performance in the control group, as predicted. These findings indicate that the direct and indirect effects of peer learning on academic performance contributed significantly to the improvement of students’ learning and performance.

Table 6.1 gives an indication of the effect size in four experiments conducted in this study. Cohen (1988) proposed some general definitions for small, medium, and large effect sizes. He categorized an effect size small if \( d = .20 \), medium if \( d = .50 \) and large when \( d = .80 \). Augmenting to Cohen’s (1988) original small, medium and large effect sizes, Rosenthal (1996) added a classification of very large, defined as being equal to or greater than \( d = 1.30 \).
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Exp.</th>
<th>Type of intervention</th>
<th>Type of technology</th>
<th>No of participants</th>
<th>Post mean Exp.</th>
<th>S.D</th>
<th>Post mean Control</th>
<th>S.D</th>
<th>Gain</th>
<th>Effect size (Cohen’s d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1</td>
<td>Collaborative learning</td>
<td>clickers</td>
<td>36 exp. 35 control</td>
<td>65.56</td>
<td>7.90</td>
<td>44.86</td>
<td>10.08</td>
<td>20.7</td>
<td>2.3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Self assessment</td>
<td>Blackboard LMS</td>
<td>52 exp. 53 control</td>
<td>62.15</td>
<td>13.34</td>
<td>50.26</td>
<td>8.56</td>
<td>11.89</td>
<td>1.1</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>Collaborative learning</td>
<td>-</td>
<td>53 exp. 53 control</td>
<td>55.30</td>
<td>6.79</td>
<td>50.26</td>
<td>8.56</td>
<td>5.04</td>
<td>0.7</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Cooperative group-project learning</td>
<td>Blackboard, Facebook, and mobile phones</td>
<td>59 exp. 59 control</td>
<td>68.76</td>
<td>9.65</td>
<td>55.1</td>
<td>7.53</td>
<td>13.66</td>
<td>1.6</td>
</tr>
</tbody>
</table>

NB: Exp. = Experimental, LMS = Learning management system
Following Cohen (1988) and Rosenthal’s (1996) classification of effect size, experiment 1 and 4 have very large effect sizes whereas experiment 2 and 3 have moderately large and medium effect sizes respectively. Overall, the results obtained from these four studies confirm that TEIE methods have a positive effect on students’ learning and academic performance. However, they suggest that in addition to TEIE methods, there are other direct and indirect variables, such as intrinsic motivation, self-efficacy, time on task and peer learning, that also contribute to students’ learning and academic performance.

6.4 Evaluation of the conceptual model

The basic notion underlying this study is that interactive engagement methods and technology, mediated by motivation, have positive effects on learning and academic performance, as presented in Figure 6.1 (Figure 1.1).

![Figure 6.1: Conceptual model](image)

From the four models tested in this dissertation, I distinguished three clusters of variables that positively affected deep learning and academic performance:

- TEIE methods
- Motivation (intrinsic motivation and self-efficacy)
- Learning variables (peer learning, time on task and help seeking)

With regard to TEIE methods cluster, lecturers should understand pedagogical methods
Summary

that use technologies productively to teach (Mishra & Koehler, 2006). Chapter 2’s findings (i.e., the direct effect of interactive engagement methods on deep learning and the indirect effects of technology on deep learning through motivation) indicate how lecturers’ knowledge of technologies, various teaching methods and content interact with one another to produce effective teaching, which improved students’ learning and academic performance.

Motivation played a role in mediating technology on deep learning in this study. By integrating technology, students became intrinsically motivated to learn. They began posting questions and comments through the Blackboard management system and Facebook to ensure their understanding of the content rather than memorising and aiming to earn higher scores without comprehension. Similarly, the mediation and interaction effects of self-efficacy on academic performance (Chapter 4) show that self-efficacy is the most important factor in improving students’ performance. The amount of time students spent on their academic work had no impact on their academic performance when combined with self-efficacy, implying that the confidence students had that they could complete tasks through technology was more important than the time allocated for the activities. Thus, when students believe that they can reach a specific goal, such as academic performance, they become more determined to do so. Furthermore, the absence of a direct effect of intrinsic motivation on academic performance (Chapter 2) is a notable outcome because it indicates that not all intrinsically motivated students improve their academic performance. Students in this study did not automatically obtain a high level of performance. Instead, they had to go further and make sense of the content, either through interaction with the content itself or through peer learning. Those who understood the content achieved improved performance.

Research shows that students learn best when they share ideas and learn from one another (Cooperstein & Kocevar-Weidinger, 2004; McKeachie, 2002). The direct effect of peer learning on academic performance in both the control and the experimental groups in Chapter 5 shows that students are also aware of this phenomenon. Peer learning seems to occur naturally to students. Thus, the control group willingly convened
informal groups during the welding project. I conclude that peer learning played an important role because students acquired knowledge and skills through helping and supporting one another during the cooperative group-project learning. The research evidence in this study clearly indicates that if used properly, peer learning can yield significant improvements in students’ academic performance. Last, deep learning also played a significant role in the learning process by mediating the effects of other variables such as interactive engagement methods, technology, peer learning, intrinsic motivation and interactive engagement on academic performance (Chapters 2 and 5).