A Design Philosophy for Persuasive Digital Learning Environments

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed.

Justin Filippou
March 2017
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Journal


Conferences


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<td>Automatic Linear Modelling</td>
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<td>DLE</td>
<td>Digital Learning Environments</td>
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<td>FBM</td>
<td>Fogg Behavioural Model</td>
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<td>FoMO</td>
<td>Fear of Missing Out</td>
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<td>MLR</td>
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<td>PSD</td>
<td>Persuasive System Design</td>
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<td>TTM</td>
<td>Task-Test-Monitor</td>
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<td>US</td>
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Glossary

As this research is undertaken in an educational context, which can sometimes use terms interchangeably, to avoid confusion, terms used in this thesis are defined as follows.

**Program** At RMIT University, a program refers to a university degree (e.g., Bachelor of Business) and is made up of a number of courses. An RMIT program is synonymous to the term "course" as used by other universities.

**Course** An RMIT course is synonymous to the term “subject” used by other universities.

**Class** Students enrolled in a course attend classes such as lectures, tutorials, labs, practicals, and/or workshops.

**Instructor** The person who facilitates a class. For example, a lecturer who conducts a lecture or a tutor who facilitates a tutorial.
Abstract

Information technology is deeply engrained in most aspects of everyday life and can be designed to influence users to behave in a certain way. Information technology designed for the purpose of behaviour change is referred to as persuasive systems. Examples of such systems range from e-commerce sites influencing bidding behaviour to social media encouraging the sharing of personal information. E-commerce and social media are effective at influencing broad demographics of people, which is increasingly becoming a priority for higher education as the number and types of students pursuing degrees continue to grow.

The aim of this research is to construct a systematic design approach for persuasive systems in the learning environment. This is to encourage students to better engage with coursework, as this is an aspect of the learning process that is often neglected by students. Students are more concerned with assessments and obtaining good grades because these are tangible outcomes that will allow them to complete their degree. The digital learning environments students use play a key role in establishing engagement between students and course materials. Currently, learning management systems such as Blackboard Learn are the most commonly used digital learning environments. However, these do not provide strong interaction between the system and the users. To address these shortcomings, a next-generation digital learning environment, Task-Test-Monitor, was selected as the base platform and was augmented by the addition of a mobile app named Study Helper to be more persuasive. The modified Task-Test-Monitor was then used as the basis for measuring the perceived persuasiveness of such a system by students.

The research was carried out over three phases, each designed to inform the next. During phase 1, two models were constructed to measure study behaviours that impacted self-perceived academic performance and behaviours that impacted a results-based measure of performance. These informed phase 2, where the persuasive system design framework was used to implement persuasive system features that supported the behaviours. The system was implemented using an agile approach over the course of two semesters, iterating features based on student feedback. Students were invited to complete a survey and participate in interviews. Phase 3 extracted persuasive factors and developed design postulates for a persuasive digital learning environment. A factor analysis was performed on the survey data.
and thematic and correlation analyses on the interview transcripts in order to develop the persuasive learning cycle model.

The results showed that students were largely in favour of Task-Test-Monitor, with 72% wanting to use it in their other courses. Over 40% of students agreed that Task-Test-Monitor influenced them, encouraged them to complete coursework and helped them change their approach to study. The factor analysis identified three contributors to successful persuasion: guidance, visualisation and learning support. These explained over 60% of the variance in the results. The thematic analysis highlighted that learning strategy, assessment and motivation were the main concerns for students. The persuasive learning cycle model showed that students seek guidance on the work they need to do, and that visually representing their progress at the point of access of materials improves students’ motivation to continue working. Instructors play a support role by ensuring the cycle continues reliably. Persuasive learning system design postulates were extracted from the model analysis.

This research has a number of implications. First, it demonstrates that a digital learning environment has the potential to be persuasive, provided it enables the persuasive learning cycle to occur. Second, instructors play an important role in the process by providing low-level support for students who require it, thus creating a scalable solution for large course enrolments. Finally, students favour a just-in-time learning model because it allows them to engage with their learning around their other pursuits and interest, which creates opportunities for persuasion to occur.

Future research should test the persuasive learning cycle model in other contexts to investigate the possibility of generalising the model. The persuasive learning system design postulates should be tested as hypotheses, which will be valuable to other digital learning environments and learning system designers.
Chapter 1: Introduction

Computer systems have rapidly advanced over a relatively short amount of time from basic data processors to personalised, service-based architectures that help users achieve their professional and personal goals. The computing devices people use today are more powerful than in any other era and can be small enough to fit in their pocket. The portability of hardware and always-available mobile internet connectivity have made smartphones and tablets immensely popular, and they provide users with unprecedented access to information and services. These services can include shopping, news, entertainment and social interaction. As technology permeates more and more facets of everyday life, people increasingly depend on it (Friedewald & Raabe 2011) and indirectly develop a sense of trust and performance expectations. One reason for increased dependency may be that technology makes life easier for its users through a combination of being useful and easy to use. Usefulness and ease of use have been shown to be predictors of technology use (Chuttur 2009) and so as technology becomes easier to use, more people will want to engage with it. Technology reduces the effort required to complete tasks or achieve goals by simplifying and supporting users through that process. In a sense, technology is doing a favour for its users, which can be an effective way to influence behaviour because people are more likely to respond to a request for action when they are returning a favour (Cialdini 2009). This creates an opportunity that system designers can deliberately exploit by encouraging specific behaviours in their users. Systems designed to influence human behaviour and attitude are called persuasive systems (Fogg 2002; Oinas-Kukkonen & Harjumaa 2009; Torning & Oinas-Kukkonen 2009). The analysis and design of these persuasive systems form the main focus of this thesis.

1.1 How Information Systems Persuade

The concept of technology persuading behaviour is particularly evident in the e-commerce field. The term “e-commerce” in itself demonstrates how technology has augmented a traditional industry and made it far more influential and persuasive than before. Commerce in its traditional definition is the trading of goods and services for financial compensation and so e-commerce can also be described in this way, albeit using electronic devices (Wigand 1997). By leveraging the power of technology to improve a traditionally geographically restricted concept, the commerce sector has replicated trading on a global scale. For example, websites
such as eBay\(^1\) and Amazon\(^2\) have become some of the largest e-commerce sites in the world; Amazon alone has over 40% of the United States (US) e-commerce market (Kam 2016). Amazon’s original innovation was to make the process of purchasing books easier and cheaper than in traditional bookstores. The Amazon website allows customers to purchase books by credit card with a few clicks, with the book being delivered to the customer’s home (that same day in the US).\(^3\) Amazon’s simpler and lower-cost process of purchasing books has led customers to return often to buy more products. Amazon’s transactions are all carried out using an online system, meaning large amounts of data about the purchasing behaviour of customers can be collected. With the buying patterns of millions of customers stored in their databases, Amazon is able to employ a “recommender system” (Ricci, Rokach & Shapira 2011) that makes predictions on the types of products its customers might be interested in buying. Products are then presented to the users the next time they log in, further increasing the likelihood of purchase. Automatic product recommendations are a clear example of system designers’ attempts to influence users to buy more products in a similar manner to traditional salespeople. Further, having the data available to personalise recommendations means that systems such as Amazon’s may be more credible and persuasive than their traditional counterparts (Yoo, Gretzel & Zanker 2012).

The auction website eBay is another example of how technology can be used to influence buying behaviours. Auctions are an effective means of encouraging people, particularly casual shoppers, to purchase by forcing them to make a decision in a timely manner, capitalising on impulsive aspects of human behaviour (Möllenberg 2004). Sites such as eBay have made the process of discovering auctions easier and created a central location from which users can buy and sell. In addition, smartphones with push notification functionalities allow online auction sites to send reminders when auctions are about to end, ensuring customers do not miss out on the items they wish to purchase. Arguably, such reminders are primarily designed to ensure more users see the end of the auction to promote bidding since this is when participants make their final investments in the auction based on the value of the item (Ariely & Simonson 2003). If users are not prompted to bid for an auction they are

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\(^1\) http://www.ebay.com.au
\(^2\) http://www.amazon.com
\(^3\) https://www.amazon.com/gp/help/customer/display.html?nodeId=201631620
watching, it is likely that they would forget about it and eBay would miss out on receiving more income from the higher final auction price.

Amazon and eBay exemplify how the e-commerce domain uses persuasive technology and how the technology successfully assists users in carrying out their goal of purchasing a product. Other industries, such as news and entertainment, are similarly successful in persuading users to engage with their content by utilising social media. Nevertheless, there are still domains in which the persuasive potential of technology can be better utilised, such as in education, health, computer security and environmental responsibility. These domains face similar challenges in successfully influencing behaviour: individuals typically are aware of what constitutes a positive behaviour in each field, but do not demonstrate that behaviour consistently. This research focuses on how to address the challenges of study behaviour by improving the persuasiveness of the systems used by students. The following section explores the current landscape of learning systems and the potential to use them to improve the learning environment.

1.2 Persuasive Systems in Education

The success of persuasive technology in e-commerce and entertainment can potentially be replicated in the area of higher education, and there is a growing need to do so. Traditionally, student behaviour could be somewhat influenced by universities, which could leverage the sense of respect generally acknowledged in society. Gaining entry into a well-respected university was difficult, so enrolled students were presumably eager to make the most of their opportunities by engaging in the learning process. This is not to suggest that all students behaved optimally; rather, the general attitude of students was that they were to learn from instructors who knew the field of study well. In recent years, the relationship between learning institutions and students has shifted. More students than ever are attending university to complete undergraduate studies and there is a broader range of academic ability. This has been described as the “massification” of education (Norton, Sonnemann & Cherastidtham 2013). Problematically, the learning environments used to teach students have not adapted to meet the needs of the more diverse student cohort. Modern universities can take a more student-centred approach to designing learning by moving from a “one size fits all” style to a more tailored learning environment (Sledge & Fishman 2014). Prioritising the meeting of student needs has altered the relationship universities have with their students. It creates a service-provider-and-customer type of arrangement (Cuthbert 2010), particularly as students
must pay substantial fees to attend the institutions. Treating students like customers means that the traditional method of influencing behaviour solely through established pedigree can no longer work. However, institutions may not need to regain their traditional influence to solve this problem. Instead, persuasive systems can be introduced into the learning environment to encourage students to engage in the learning process and help meet their needs.

Persuasive systems can play two key roles. First, all universities compete to attract the best students since enrolling high-achieving students will likely lead to improved performance for the whole university. To attract these students, universities should construct a learning environment that puts the student first (James et al. 2015). This includes the physical (e.g., buildings, equipment and teaching spaces) and digital (e.g., online resources and systems) areas of the learning environment, which should be improved as regularly as is feasible. Second, the general population, which includes students of all ages, have become used to technology making their life easier, as in the e-commerce examples given earlier. In contrast, the traditional university environment was designed to be challenging so that students could grow their intellectual capacity. Therefore, while students may expect and seek universities with a technology-supported learning environment, many Australian universities’ technology is limited to assisting students with their administrative tasks, such as grade recording and document retrieval, and is not necessarily designed to simplify the learning process. As a result, students may be discouraged from engaging with their learning due to the perceived heightened difficulty, leading to procrastination (Harrington 2005; Milgram, Sroloff & Rosenbaum 1988), a common means of dealing with stress (Deniz, Tras & Aydogan 2009). Persuasive systems may be able to alleviate this problem by assisting students in their study process, thereby improving engagement with learning. The next section explores why students need encouragement to engage in their coursework.

1.3 Motivation for Conducting the Research

Increasingly, full-time students are investing their time in a diverse range of non-academic and leisure activities, such as sport, fitness, music and various personal interests. In addition, the number of full-time students that work part-time has been steadily increasingly over the last few decades, with approximately half of all younger students in Australia working part-time (ABS 2013). As a result, students are under increased time pressure, and are seeking ways to more efficiently use their study time. One efficiency strategy that students use is to
focus on completing assessed work in lieu of completing unassessed learning activities. Although this reduces the amount of time and effort required to pass a course, it is damaging to long-term skills and knowledge development since higher-order skills are built upon sound basic skills (Bloom 1956). This issue may not be obvious to students, particularly first-year students, who have not yet been in a professional work environment where the more advanced skills are required. Thus, many students choose to invest their time in assessments that directly lead to a degree, which enables employment, which in turn provides money for living expenses. This cycle presents a challenge to institutions: the quality of graduates will eventually decline if students focus on passing assessments and prioritising by-products of learning (grades), rather than developing higher-order skills to optimise their job performance.

Another issue facing higher education institutions is that their learning environment is not always designed to support students in their learning. In particular, digital learning environments (DLE) that students use tend to be oriented around administrative aspects, such as grades, lecture slides and tutorial notes. Students require motivation to engage with course content to learn and develop the necessary skills. It can be argued that a learning system simply needs to enable students to carry out coursework, and motivation to do so should come from instructors or students themselves. However, while possible, it is not feasible for instructors to do this, particularly as enrolment numbers continually increase. Providing students with personalised feedback and motivation in large numbers would place unreasonable stress on instructors, which can potentially lead to lower quality feedback being given.

Education is facing similar challenges that e-commerce did several decades ago. With rapid expansion in the potential market of customers/students, there is a need to provide personalised, persuasive and scalable systems to attract and retain customers/students. This provides an opportunity to investigate whether the application of persuasive systems can help address these issues in education. However, unlike in e-commerce, education has a unique problem in that instead of purchasing a product, students need to develop skills and acquire knowledge. This means a persuasive system for education will operate with unique factors. Through analysis of such a system, a persuasive design approach can be constructed for education.
1.4 Project Aims and Scope

The aim of this thesis is to develop a systematic design approach for persuasive digital learning environments. In the longer term, ideally, a persuasive system would be created that encourages students to develop study habits that can lead to improved learning outcomes. A habit is any behaviour that has been repeated enough times so as to become second nature to the individual (Andrews 1903), which, in the case of education, would be performing study behaviours of high-achieving students. To begin the process of repeatedly performing a beneficial study behaviour, however, one must be persuaded to do so. This is where persuasive systems can be useful.

Typically, persuasive systems are discussed concurrently in terms of persuasion and behaviour change, with actual behaviour change used to measure the success of the system. However, since persuasive technology is new to higher education, it is prudent to separate those two aspects as distinct phases. That is, first evaluating the persuasive potential of a system, and then measuring behaviour change resulting from such a system. This will ensure that the system has been successfully designed and implemented to be persuasive. Then, any changes in study behaviour can confidently be considered a direct result of the persuasive system’s influence, and not a result of the novelty of a new system. Overall, this process can be summarised into three discrete stages of progression towards persuading student habits, as shown in Figure 1.

![Figure 1: Stages of persuading behaviour](image)

To enable focus, only the first stage of the process is performed in this thesis. That is, only the persuasiveness of the learning system that students use as part of their undergraduate courses is evaluated and its persuasion modelled. Setting the research with these boundaries, a set of questions can now be devised to guide the research.
1.5 Research Questions

To build persuasive systems that are effective for modern learning environments, it is important to understand the factors that contribute to the success of such a system and develop design directions to facilitate future development. This is why this research, prior to identifying factors for success, evaluates the current landscape of student study behaviour to identify what is working well for students. Then, a persuasive system is implemented using those behaviours as a baseline, and the factors leading to perceived persuasiveness by students measured and modelled. Finally, high-level design directions are extracted to enable future development of persuasive DLE. The goal is to answer the following research questions:

1. What impact does existing student learning behaviours and strategies have on academic performance?

2. How can persuasion in a learning system be modelled, and what factors enable it?

3. How can systems be designed to persuade students to better engage with their studies?

It is anticipated that this research will make a number of useful contributions to education and learning in general. These include increased understanding of current trends in learning behaviour, and enhancement of the field of information systems through improving the user experience of DLE.

1.6 Methodology

As outlined earlier, the thesis research questions are concerned with identifying the factors enabling persuasion in a DLE and the development of design directions for building such a system. The three research questions require three phases of research be undertaken to answer each question, with each phase informing the next. Phase 1 seeks to understand how students currently behave to comprehend the learning environment better. Phase 2 enhances a system using persuasive principles. Phase 3 identifies persuasive factors and design from that implementation. These phases are summarised in Figure 2.
To carry out phase 1, an existing study behaviour survey instrument called the Motivated Strategies for Learning Questionnaire (MSLQ) is used. The instrument features 81 items that cover a range of different behaviours across several categories of behaviour and motivation (Pintrich 1991). Automatic linear modelling (ALM) is performed to determine the most impactful of these items on two measures of academic performance: a self-perceived performance measure and a results-based measure. The results of the ALM are used to perform multiple linear regressions (MLRs) in order to identify three to five of the most impactful behaviours on each of the performance criteria. The process is then repeated on two subsets of the data, current students and alumni, to analyse any differences between the immediacy of studying against the reflective responses of graduates. As alumni have successfully completed their degrees, possibilities are explored on how they achieved this and how current students can be encouraged to acquire the behaviours of graduates.

Phase 2 initially involves selecting a system platform on which the persuasive enhancements are added. Using the persuasive system design (PSD) as an evaluation framework (Oinas-Kukkonen & Harjumaa 2008), an assessment is performed of a common DLE that many students in Australia use: Blackboard Learn (henceforth “Blackboard”). A next-generation DLE, Task-Test-Monitor (TTM), is also evaluated for its inherent persuasiveness. Next-generation DLE differ from traditional DLE by being more student-focused and designed to support students in their studying and learning process. It is determined that TTM has greater potential for persuasion due to its tighter focus on supporting the learning process rather than the administration of learning. The results of phase 1 are then used to identify or design new persuasive features in the system and assess the current issues students are facing with performing those behaviours through the lens of the Fogg Behavioural Model (FBM).

Finally, during phase 3 of the research to identify the success factors, a data collection and analysis is carried out using a mixed-methods approach. Students use the persuasive system for an entire semester of 12 weeks, at the conclusion of which they are asked to complete a survey designed to assess the system on its implementation of the PSD. These data are used
to perform a factor analysis in order to uncover the factors that facilitate persuasion in a DLE. Next, students are invited to participate in interviews designed to explore in depth why the system was perceived to be persuasive and shed more light on the factors identified. A thematic analysis is performed on the interview data and a correlation analysis is completed to uncover relationships between themes directly. These analyses are combined to form an overall model of how persuasion operates in a DLE and postulates are extracted from the model and data.

1.7 Significance and Contribution

This research is significant in a number of ways. First, the behavioural analysis conducted as a precursor to the persuasive design of the TTM system used in this research provides a useful contribution to the field of education in general. Persuasive technology is only one application of technology for behaviour change, and the models produced from this phase can be used for other areas of research. For instance, understanding behavioural patterns of students can help instructors better design effective pedagogy to engage students in their learning process. Second, given that the application of persuasive technology is relatively new to the domain of education, the factor analysis in this thesis provides empirical evidence as to whether persuasive technology is an appropriate avenue for addressing issues in higher education. Identifying persuasion factors could motivate further research to build systems in accordance with the factors. In particular, identifying success factors supports continued development of a persuasive learning system to eventually form positive study habits.

1.8 Thesis Outline

This chapter introduced the topic of study. The rest of the thesis is structured as follows:

Chapter 2: Literature Review. This chapter explains the crucial pieces of theory used in this research, including how human behaviour operates and can be influenced or persuaded. The PSD framework is then detailed. Next, DLE are discussed, as are the challenges universities face in implementing these sorts of systems to better engage students. Relevant teaching and learning literature are discussed to provide grounding in the persuasive design choice later in the thesis. Finally, the chapter provides related examples of persuasive systems from other fields that attempt to solve similar problems of influencing behaviour.
Chapter 3: Methodology. This chapter presents the overall research design and the rationale of having three phases of research. The survey instrument developed for phase 1 and 3 is detailed, as is the distribution method used to recruit participants and the statistical analyses conducted to produce the behaviour models, factors, thematic analysis and postulates.

Chapter 4: Behavioural Analysis. This chapter provides the results and a discussion of phase 1 of the research, which is the current positive study behaviour analysis. Two models are presented for the types of behaviours and motivation demonstrated by students when they study. Behaviours identified in the sample collected are discussed, followed by an investigation of the differences between the types of behaviours current students exhibit and graduates reported. Then, categories of behaviours in terms of Bloom’s taxonomy are explored to identify any potential to move current students from the lower levels of the taxonomy to the higher levels shown by graduates.

Chapter 5: Selection of a Learning System Platform. This chapter assesses two existing learning systems, Blackboard and TTM, for their potential to be used as the basis of a persuasive learning system. Both systems offer strong primary task and credibility support, while dialogue support has only small implementation, and social support is missing from both. Ultimately, TTM is selected due to its stronger focus on supporting the core learning process rather than the administrative aspects of learning to which Blackboard is better suited.

Chapter 6: Designing and Enhancing Persuasiveness in Task-Test-Monitor. Several key aspects of the design process are carried out in this chapter. First, the positive study behaviours identified in Chapter 4 are grouped with system features that can support those behaviours. Second, as a first step to addressing the lack of dialogue support for TTM, a purpose-built mobile application (henceforth “app”) called Study Helper is presented. The app allows direct communication with students using push notifications. The features for both the existing TTM web platform and the newly created Study Helper app are analysed using the FBM to assess their likelihood of acting as effective triggers.

Chapter 7: Results and Discussion. The system outlined in the previous chapter is used by students for a semester spanning 12 weeks; this chapter reports and discusses the results. First, the results of the descriptive statistics, factor, thematic and correlation analyses are presented. They are then discussed using the categories of the persuasive factors, in which a
series of postulates are identified. This chapter answers both the second and third research questions.

**Chapter 8: Conclusion.** This chapter summarises the three phases covered in the research and revisits the problem of how to build a successful persuasive learning system. The implications for information systems and education theory and practice are discussed. Potential for future research to extend the exploratory results is proposed.

**1.9 Summary**

Massification of higher education has altered the relationship universities have with their students. This is changing what students expect from their university experience, and therefore universities need to rethink how their learning environments are designed. Further, students are leading busier lives than ever before and, with more students working part-time while studying full-time, are becoming more interested in the return on investment for their time spent studying. The motivation to complete foundational coursework is being left to instructors to encourage, which is not feasible as enrolment numbers grow. However, technology can be used to overcome these barriers and provide a scalable method of influencing students to complete more coursework. To achieve this, a systematic design approach needs to be developed, which will provide the groundwork for future habit-forming DLE to be created.
Chapter 2: Literature Review

2.1 Overview

The term “persuasive systems” encapsulates various aspects of human behaviour and technology, and a review of the current research in these areas is presented here. The chapter begins with a discussion of the workings of human behaviour because this underpins all of the persuasion and technological theories used in this research. Next, the ways in which behaviour can be influenced are discussed, as are models that describe the role behaviour plays in technology use and acceptance. Technology designed to persuade behaviour is explored, with a particular focus on the PSD framework. The current state of DLE is reviewed, as are learning theories to uncover the behaviour issues to be alleviated by persuasive systems. The chapter concludes with a review of related examples of PSD from other areas such as health and computer security.

2.2 Understanding Human Behaviour

Human behaviour is complex and various factors contribute to an individual behaving in a particular manner (Ajzen 1985). People do not always behave according to logic and reason, and are often affected by a number of cognitive, social and memory biases. For example, people are likely to seek information that matches their preconceptions, which is known as confirmation bias (Nickerson 1998). People also act in ways that continue the status quo, which is a form of system justification bias (Jost, Banaji & Nosek 2004) in which people are happy to maintain the current system or social order without challenging it. These two examples of behavioural biases begin to explain the challenges of changing attitude and behaviour: there is an inclination towards maintaining what is perceived to be currently working. In the case of students, their sub-optimal motivation towards study may be a result of their successful progression to higher education, and so there is little incentive to want to improve what has worked for them so far. Further exacerbating this is consistency bias, in which attitudes and behaviours from the past are thought to be the same as they are now (Cacioppo & Berntson 2002). For example, in the past, students may have been more highly motivated or had more positive attitudes towards learning than at present, but incorrectly assume they have not changed. The challenge in this research is to understand such
preconditions, and attempt to overcome them. To do so, the underlying behavioural factors and their relationships to each other need to be further investigated.

A prominent theory that models some of the aforementioned complexities is that of planned behaviour (Ajzen 1985, 1991). This theory outlines how attitude, subjective norms, perceived behaviour control and behavioural intention determine actual behaviour in an individual. Figure 3 outlines these factors and their relationships to one another. Behavioural intention is closely tied to motivation, in that the more willing someone is to perform an action, the more likely he or she will do so. This is also determined by one’s attitude towards performing the action. In the context of higher education learning, if a student is motivated to study, it may be because of their attitude regarding the value of improving their knowledge. Alternatively, poorly motivated students may not value the benefits of study, and hence do not perform the foundational skill-building exercises that would allow them improve their knowledge. Behavioural intention is also determined by perceived control over one’s ability to perform the action. Unless a person has opportunity and resources available to them to carry out a behaviour, then it is unlikely they will do so, regardless of their motivation (or behavioural intention). Many university students would likely not suffer from this problem as much as they would from lacking motivation to study. The final component, subjective norms, has an influence on all three of the other determinants, which is to be expected as it represents how social influence can impact whether or not one desires to perform an action or not. Social influence’s role in education is clearly evident, as students typically act in accordance with the social structures of which they are members. For instance, a student who works with others who study regularly is more likely to emulate that behaviour.
The theory of planned behaviour model is useful to consider when building a persuasive system because it explains the relationship between attitude and behaviour, which are the two core targets of any persuasive system. Further, the separation of behavioural intention and behaviour has implications for how designers should view behaviour change in a persuasive system. That is, behavioural intention being a determinant of actual behaviour implies that persuasive systems should attempt to influence attitude and intention to behave and not the behaviour directly. Manipulating behaviour directly may be considered coercion because it would be forcibly altering how someone behaves. This is an important distinction to make because coercing people, such as students, to behave in a specific way is unethical. A more ethical approach is to understand how to target behavioural intention and gradually shift peoples’ behaviours to a desirable state. To do so, behaviour change models need to be examined.

### 2.2.1 Behaviour change models

Modelling the ways in which behaviour can change has been done a number of ways. Two such models are the stages of change model (Prochaska & Velicer 1997), also referred to as the transtheoretical model), and the SNAP (Smoking, Not smoking, Attempting to stop, Planning to stop) model (West 2009). The stages of change model outlines the distinct phases individuals progress through when attempting to alter their behaviour. These stages include: pre-contemplation, contemplation, preparation, action, maintenance and termination (see Figure 4).
During the pre-contemplation stage, an individual is unaware that there is a need for change and has no intention to alter their behaviour. The point at which the individual becomes aware and is considering altering their behaviour happens during the contemplation stage. A plan to change behaviour is formulated during the preparation stage. A change in behaviour that has been initiated signals the action phase being entered. After initiating the change, the individual typically attempts to prevent a relapse in behaviour and are in the maintenance stage. Finally, when an individual has reached the termination stage, they will no longer continue the prior undesirable behaviour. The typical timeframe for each phase is six months for the stages between pre-contemplation and action, and between six months and five years for the maintenance stage (Prochaska & Velicer 1997). The implication of timeframes being the driver of progression, however, arguably does not reflect what happens in reality (Littell & Girvin 2002). Rather, individuals may change their behaviour for unpredictable reasons and may progress backwards and forwards through certain stages of change at any point. Further, some stages in the model have been criticised as being arbitrarily defined and therefore not useful (West 2005).

Addressing the deficiencies of the stages of change model, the SNAP model outlines changes in behaviour as a continuous process (West 2009). The basic premise of the model is that individuals set themselves a rule that is their desirable behaviour. For instance, “I will quit smoking”. The individual then fluctuates between four different states. The model was
originally created as a smoking cessation model and the states are labelled for that context. However, the model can be relabelled to apply to non-smoking related scenarios (West 2009) (see Table 1).

Table 1: SNAP model of behaviour definition

<table>
<thead>
<tr>
<th>Original Model</th>
<th>General Purpose Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>S  Smoking</td>
<td>Staying with the old behaviour</td>
</tr>
<tr>
<td>N  Not smoking</td>
<td>New behaviour engagement</td>
</tr>
<tr>
<td>A  Attempting to stop</td>
<td>Attempting to change</td>
</tr>
<tr>
<td>P  Planning to stop</td>
<td>Planning to change</td>
</tr>
</tbody>
</table>

SNAP argues that motivation is not accurately represented in linear and discrete stages. Rather, one may jump from planning, attempting, performing or not performing a change in behaviour in any direction. This is because individuals do not make choices about their behaviour rationally, but with instinct and habit. The feeling of an individual wanting to do something versus the feeling that they ought to change their behaviour is the main catalyst. For instance, an individual may know they ought to stop smoking, but their feelings of wanting to smoke outweigh the feeling that they should stop. A range of factors can influence why the individual wants to smoke; if something happens to reduce the feeling of wanting to smoke below the level of knowing they should stop, then a change is likely to occur. However, this is not permanent, and extenuating circumstances may elevate the feeling of wanting to smoke once again. This is an indefinite and continuous process that can proceed in any direction. Figure 5 shows the possible paths of SNAP, and Figure 6 represents a more generalised version of the same model.
Comparing both of the presented models, stages of change alone may not be accurate enough in providing an effective intervention in changing an individual’s behaviour. However, it does provide a useful high-level view of the process of change. The SNAP model appears to more accurately represent how behaviour works. These two models are often discussed in competition with each other (Prochaska 2006; West 2005, 2006), but it may be more appropriate to think of each representing different levels of abstraction. The stages of change model may be better suited to outlining the higher-level process, whereas the SNAP model can better outline the lower-level workings of human behaviour change.

2.2.2 Fogg behavioural model

One dimension that the stages of change and SNAP models do not address is how behaviour can be triggered. There is an unstated assumption that behaviour simply occurs, but it can be argued that behaviour depends on two aspects to be present: motivation and ability. The theory of planned behaviour represents these constructs as behavioural intention and perceived behavioural control, respectively. However, it does not specify any trigger mechanism to begin the process of behaviour change. One model that does is called the Fogg Behavioural Model (FBM) and it helps improve the understanding of this process by mapping the relationship between motivation and ability and at what point behavioural triggers can be effective (Fogg 2009a). In the FBM, triggers can only be effective when an
individual has both sufficient motivation and ability to perform the action (see Figure 7). Unless an individual has the necessary skills to do something, they will be unable to do so no matter their level of motivation when prompted. A lack of motivation to do something despite having the capability will also fail to encourage the person to act when triggered.

![Fogg behavioural model](image)

*Figure 7: Fogg behavioural model (reproduced from Fogg (2009a))*

There are several ways to interpret the real-world impact this model has on how one can overcome issues with motivation and ability. One way to help ensure behaviour triggers become effective is to increase motivation, for example, by providing a reward, or to increase ability by training the person to be better at the task required. Another option is to make the task easier, reducing the required skill level. To address the ability component, it would be easier for a system designer to reduce the effort required rather than invest large amounts of time and effort in upskilling the person. As in this current research, if the task itself is related to skill development, then ultimately the individual will benefit from the experience in a meaningful way. The FBM resonates with the issues of student study behaviour: if a student is lacking the ability to study effectively, they will be very unlikely to be able to respond to triggers to do so. If a student is capable of studying effectively but lacks any desire to do so, then this too will make it difficult to encourage the student to act. Thus, triggers need to be designed by first assessing the levels of motivation and ability, then correcting those issues. As a result of this implication, using the FBM will be of use when analysing and designing system features to influence study behaviour.
2.3 Influencing Behaviour

At its core, the purpose of any persuasive system is to influence or persuade the attitudes and actions of its users. Despite people having a range of behavioural biases (such as confirmation and status quo bias) that make them resistant to changing their behaviour, people can be influenced in various ways. For example, Cialdini (2009) lists six methods to influence behaviour: reciprocation, commitment and consistency, social proof, authority, scarcity and liking.

Using reciprocation to influence is a simple yet effective approach. Most people, when provided with some form of favour, are likely to return that favour by doing more than what would be equal. This could be due to people feeling they owe a debt of gratitude on top of the required effort to perform a task. The concept of commitment and consistency works on the premise that when someone makes a commitment to do something, they are more likely to repeat that behaviour again. This may be due to the role motivation plays in behaviour, in that when making a commitment the individual has somewhat internalised their desire to do something. The different forms motivation can take are explored in the following section of this chapter, which could explain why students may or may not be optimising their study behaviour. That is, students who fail to make a full commitment to their study (because of demanding work schedules or other external factors) are then less likely to perform the action of studying, and so the cycle of committing to and executing study breaks down. Adding a social element to motivation leads to social proof, which suggests that people are likely to behave in accordance with others in their social group. Otherwise known as social motivation or peer pressure, this can be an effective means to influence behaviour. A common result of this type of influence is group think, where the thoughts and attitudes of the individual are overshadowed by that of the entire group for fearing of falling out of favour (Janis 1972; Rose 2011). This can be dangerous if not managed properly, and in the case of higher education, would need to be carefully handled because students’ individual critical thought is more desirable than is the need to influence their study behaviour.

Authority figures typically have higher likelihoods of influencing individuals. Power is revered in society, and they who possess it are often perceived as being worth listening to and following, particularly when an individual shares a common goal with the authority figure and consents to control (Grimes 1978). This is supported by the system bias (Jost, Banaji & Nosek 2004) exhibited in humans, who wish to uphold the system and maintain the status quo.
As discussed in Chapter 1, universities can no longer rely on reputation alone to influence a more diverse student cohort entering higher education with differing goals. Nevertheless, instructors still carry some authority through their advanced knowledge, and it is likely that a persuasive learning system will stand to benefit from leveraging that authority, rather than the institutional authority of past years.

Another avenue of influence is scarcity, which, when created purposefully, is the deliberate limiting of availability of something. This generates a heightened desire for the scarce resource. Its use is perhaps most prevalent in marketing and advertising, where products are created as “limited editions” so as to make them worth more. Scarcity is easily understood as the traditional supply and demand curve in economics. As supply is constrained, demand for that item increases, thereby raising its value. Simply restricting supply should not logically lead to increased demand; however, people tend to value something more highly if it is in short supply, particularly if purchasing a product for themselves (Wu & Lee 2016). This makes sense for resources of value like gold, which can be made into jewellery. If a restricted resource can be used for social status or some other advantageous use to the individual, then restricting its availability will likely lead to higher valuation. This is a difficult avenue of influence to leverage in education because restricting access to education is unethical. However, it could explain part of the lack of desire to complete programs to a high standard since higher education is increasingly available to others. The value of an undergraduate degree has fallen because it is more common than before (Hesseln & Jackson 2000). Nonetheless, students still need a degree to compete for employment.

The liking principle is that people are more easily influenced by people that they like. This may be due to the relationship trust has with liking someone. People like others that make them happy and someone who causes this effect is not a threat, can be trusted and therefore more likely listened to. Coupled with peoples’ motivation to belong to social groups, it stands to reason that individuals who are liked can be quite influential. As has been evidenced anecdotally, in teaching, instructors who are well liked by their students may often find they can persuade students more easily to engage with the course content.

2.3.1 Motivation

Motivation is more than someone being motivated or not. Arguably, there are three broad categories of motivation: amotivation (having no motivation to perform an action), extrinsic
motivation (being driven to perform an action by an external force) and intrinsic motivation (performing an action due to one’s own will) (Ryan & Deci 2000). There is a range of subtypes within extrinsic motivation: external regulation, introjection, identification and integration. Table 2 summarises the different types of extrinsic motivation.

Table 2: Motivation scales (reproduced from Ryan and Deci (2000))

<table>
<thead>
<tr>
<th>Motivation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>External regulation</td>
<td>An individual who is motivated because of external rewards or punishments for compliance.</td>
</tr>
<tr>
<td>Introjection</td>
<td>Actions are primarily performed for approval from others.</td>
</tr>
<tr>
<td>Identification</td>
<td>An individual begins to personally value the activity, and the effect of external forces is reduced.</td>
</tr>
<tr>
<td>Integration</td>
<td>An individual prioritises the goals of performing the desired action, which indicates that the action is of personal significance.</td>
</tr>
</tbody>
</table>

Both intrinsic and extrinsic motivation can be leveraged to influence how people behave. Extrinsic motivation is arguably the more popular route used to encourage people to take action as it is reactive to outside triggers, thereby making it an obvious and easier means for people to use. For example, external regulation describes how people will be motivated to behave based on rewards or punishments for compliance. A typical implementation of this type of motivation system can be found in any job market. Jobs that are more demanding typically come with higher wages, and people who are more susceptible to external regulation may find themselves highly motivated by those roles. As one moves across the spectrum of extrinsic motivation, the motivation becomes more internalised, as is true for integration, in which more personalised goals are the motivating driver of behaviour. The tougher type of motivation to leverage is intrinsic, which by definition needs to come from within the individual. Intrinsic behaviour means the person is solely motivated by their own desire to do something. This type of motivation either exists in a person due to a strong sense of self-discipline and willpower acquired through various means, or it can be encouraged by first triggering external cues in a person and slowly moving them towards intrinsic motivation by adjusting the type of trigger used. Figure 8 summarises the types of motivation.
In the context of study behaviour, intrinsically motivated students can be thought of as the self-starter type of student. Traditionally, higher education students who performed well are very likely to have been intrinsically motivated. This motivation was probably instilled prior to enrolment since it is unlikely that the learning environments forged it systemically. As a result, this research holds the view that the learning environment needs improvement because most students now are arguably more extrinsically motivated. As discussed, for many students, obtaining a degree is an external compliance requirement (external regulation) necessary to gain the skills to find suitable employment. While this is primarily for job satisfaction, students are also concerned about salary and promotion opportunities (Marinas, Igret & Agoston 2014). They desire a reward for their effort. Some students may study at university to please others (introjection), such as parents (potential authority figures) who encourage their children to study. Other students, presumably those who have moved through these previous stages, are either at the identification or integration stage of extrinsic motivation, and have begun valuing or prioritising the goal of completing their studies to a higher level. Given the large variety of students who are extrinsically motivated, and that these types of motivations can be triggered, there is an opportunity to encourage students to become more intrinsically motivated by means of a system specifically designed to leverage these behavioural loopholes.
An example of a popular type of computer system that leverages external motivation is social networking sites. Facebook\(^4\), Twitter\(^5\) and Instagram\(^6\) are particularly popular with university students because they allow students to stay in contact with a large number of friends. These systems mostly rely on introjection: people are highly motivated by the others’ approval shown through liking, sharing or retweeting. Social networking sites have influenced the behaviour of people of various ages, especially younger students, to the point that it is common to witness people obsessively checking these websites or apps for updates. This introjection cycle may be a result of a Fear of Missing Out (FoMO), which is a phenomenon involving the feeling that other people (particularly friends) are having rewarding experiences for which one is not present (Przybylski et al. 2013). Students who experience FoMO are evidently more externally motivated as the need to be part of a group of others is a pressing concern for them. Przybylski et al.’s study found that students who exhibit high levels of FoMO are more likely to use Facebook during class. This may explain part of the reason why social media is seen as a distraction in a learning environment: students may be more concerned with what their friends are doing rather than what they themselves are currently required to do. Being easily distracted in class also suggests that students are not engaged with their learning environment. This does not mean that learning environments should be designed to simply exploit the extrinsically motivated students, but rather, if social networking sites can use external motivation effectively to influence behaviour, DLE could too. Unlike social networking sites, the DLE’s use would directly benefit students’ learning outcomes by helping them perform better academically and potentially internalise their motivation for wanting to learn. One way to make a DLE more engaging could be through the use of gamification.

### 2.3.2 Gamification

Many people enjoy playing games, and the fun they produce can make them motivating and engaging. This is perhaps why they have become so popular, especially interactive video games. In recent years, there have been calls to transplant the enjoyable, motivating and engaging aspects of games to other purposes, which has led to gamification. Gamification involves using elements of games, game design and thinking in situations or systems that

\(^4\) http://www.facebook.com  
\(^5\) http://www.twitter.com  
\(^6\) http://www.instagram.com
would otherwise not be considered games (Deterding et al. 2011; Kapp 2012; Zichermann & Cunningham 2011). The goal of this process is to make the experience more enjoyable for the user and improve motivation and engagement. A common misconception is that gamification involves converting the target application into an actual game. In fact, the intention of gamification is to make the experience more game-like (Muntean 2011). This is achieved by strategically implementing certain enjoyable aspects of games without actually creating a game. If a full game is required, then the designers would be better off developing one with that intention from the beginning since creating fully-fledged games takes considerable resources (Totilo 2013) and a gamified system may not meet the requirements. Gamification, when applied to systems design, augments the experience rather than fully replaces it. For example, points and leaderboards are two game elements that could be applied in a system to “gamify” it. Users may be awarded points for completing certain tasks in a system and the leaderboard may serve as a motivator to encourage users to be at the top of the list. These mild game design features may be appropriate for a help desk department (Conger 2016), to encourage more service requests to be closed off by staff. However, if the intention is to create a competitive virtual environment to encourage people purely for enjoyment, then a fully 3D computer game may be a better choice. In that case, gamification would have a limited ability to achieve that goal.

One reason gamification would be useful to improve engagement and motivation is because it replicates the compelling effect games have on people to perform actions that have little real-world value while thoroughly enjoying the experience. This ability to influence people’s behaviour could potentially help solve the problem this research addresses, particularly in encouraging fruitful actions such as studying. If a learning environment is more game-like, then students will enjoy it more and may be more inclined or motivated to complete coursework. An example of a successful implementation of gamification is the app Quick Quiz (Cheong, Cheong & Filippou 2013). As part of in-class activities, students are given a short five-question multiple-choice quiz that tests their knowledge of the topic they are studying. Points are awarded on a time-based scale ranging from 40 to 100 for a correct answer, with every second removing a point from that total. Incorrect answers are given 20 points to encourage answers to be attempted, with no attempt at an answer awarded zero points. The scores of each student are then presented at the end of the round on a leaderboard. The instructor has a view that displays the answers given by the class on average, providing an opportunity to detect and correct misconceptions about the course material. This
implementation of gamification was successful at fostering an atmosphere in the classroom that students enjoyed, and only used several basic yet well-crafted game elements to achieve this. The points and leaderboards were effective at getting students to invest time and effort in the Quick Quiz system. Nevertheless, there are other ways to encourage students to invest in the use of a system.

2.3.3 Hook model

The goal of any system designer is to create something that people will want to continually use. The longer people spend using a system, the more entrenched they will become, reducing the likelihood of moving on to another system or platform. Social media platforms such as Facebook, Twitter and Instagram have been able to convince large numbers of users to invest large amounts of time in using the product. In other words, these users are “hooked” on using the services, as their use has become habitual. One model that describes how this process occurs from initial to habitual use is the Hook model (Eyal & Hoover 2013). It features four sequential stages that are endlessly repeated (see Figure 9). First, a user needs to be triggered to perform an action, either from an internal or external cue. Initially, the user is more likely to require an external trigger, as there may be minimal internal desire to perform an action. Second, the user will need to perform an action, which is a small amount of work in anticipation of a reward. Next, the user needs to be rewarded for performing the previous action. The reward is not required immediately and can be given in a variable amount of time. The variability of random reward also provides stronger positive reactions to the reward. Finally, the system needs to allow the user an opportunity to have some sort of investment in the system, which will increase the likelihood of the user returning. By investing some time or effort into the system, the user has established a connection to the system and will want to return.
26

An example of how the hook model is used in commercial web applications is apparent in how LinkedIn\(^7\) functions. When a user initially joins LinkedIn, the website displays an empty progress bar indicating that the user’s profile needs to be completed. This is an external trigger. The user then clicks on the link to improve their profile, which is an example of an action being performed. After some time has passed, the user is sent an email highlighting that their profile has since been viewed by many people because of the details the user provided, rewarding the user for their action. The user may then elect to make a connection with the other users, indicating that an investment has been made by the user and therefore is likely to return.

2.3.4 Limitations of standalone models of behaviour

Gamification and the hook model can be successful in improving motivation and engagement to influence people to enhance their enjoyment of using a system, which ultimately becomes a habit. However, these models of system design may be too abstract to use as an implementation framework for an entire system capable of influencing behaviour. Given the diverse range of students being targeted for this research, a systematic framework would better serve as a guiding theory. This is not to suggest that gamification and the hook model are not valid ways to think about how a system should be designed and how it should operate; rather, the models do not provide strong guidance for designers on what specifically needs to be implemented in order to be successfully influential. Gamification appears better suited to dealing with issues of motivation and engagement, and the hook model was primarily created to help form habits of use within a system. It can be argued that each of these are tools to help

\(^7\) [http://www.linkedin.com](http://www.linkedin.com)
improve or overcome specific problems in a system. This thesis establishes a baseline persuasive system that is intended to encourage students to better engage with coursework. Gamification and the hook model are reconsidered at a later stage of the system development process since they are both arguably dealing with designing a system to be persuasive. Of more value to this research is a higher-level theory that unifies behaviour, motivation and system design. The guiding theory should also be compatible with these two processes.

2.4 Persuasive Systems

A persuasive system is designed with the intention to influence the user’s attitude and behaviour in some manner without the use of coercion (Fogg 2002; Oinas-Kukkonen & Harjumaa 2009; Torning & Oinas-Kukkonen 2009). As personal computing has become more powerful, researchers have noticed the potential in technology’s ability to persuade people to act. Fogg (1998) described this as “captology” (Computers As Persuasive Technologies) and outlined three functions that computers serve that help them to be persuasive. The functional triad includes computers as a tool, as a medium and as social actors. At the tool level, computers provide practical help with things such as calculations, which is the more traditional view of computing’s purpose. Technology as a medium refers to platforms that may include virtual reality or social media. Finally, computers act as social actors in the many virtual assistant implementations of current smartphones, such as Siri, Google Assistant or Cortana. As can be deduced from the functional triad, there is ample opportunity for computers to be integrated deeply in people’s lives. For a persuasive system to be successful in carrying out its purpose it needs to affect individuals by reinforcing, changing or shaping either one’s attitude or behaviour (Oinas-Kukkonen & Harjumaa 2008)

The terms “persuasive technologies” and “persuasive systems” are used interchangeably in the literature, but it can be argued that there is a difference between the two. A computer system can be defined as an amalgamation of various individual technologies. As users are acquiring greater amounts of individual technologies in their lives, the effectiveness of a single piece of technology having great influence is likely to be reduced. Hence, a system of technologies is more likely to be effective in bringing change to attitudes and behaviours.

9 https://assistant.google.com/
This can also be seen in the variety of categories in which technology has been implemented, with desktops, laptops, smartphones and smart watches all working seamlessly together, leading to ubiquitous computing. The focus for this thesis is the design of a system rather than a single implementation of technology. The argument that a single piece of technology is not likely to persuade people follows on section 2.3’s suggestion that, despite gamification and the hook model being valuable persuasive tools, they do not prescribe how to build an entire system to make use of them. They are a tool or a guiding principle that may be better utilised when integrated into the design of a larger persuasive system. Alternatively, the PSD model guides the development of an entire system.

2.5 Persuasive System Design Model

As the usefulness of persuasive systems becomes clearer to researchers, there have been calls to unify the various theories of attitude and behaviour, influence and persuasive technology. This has resulted in the PSD model (Oinas-Kukkonen & Harjumaa 2009). The model integrates various components including theory of planned behaviour, captology, and the principles of influence (Kegel & Wieringa 2014), providing designers with a single framework to guide the design of their own systems. The PSD model merges the various work into three key phases: (1) understanding key issues behind persuasive systems, (2) analysis of the persuasion context and (3) the design of the system qualities (Oinas-Kukkonen & Harjumaa 2009). Figure 10 provides an overview of the entire PSD model.
2.5.1 Phase 1: Seven postulates of Persuasive Design

The first phase of the PSD does not involve specific design decisions, but is dedicated to understanding seven key postulates that persuasive systems need to align with to succeed. These include (Oinas-Kukkonen & Harjumaa 2008, 2009):
1. Information technology is never neutral.

2. People like their views about the world to be organised and consistent.

3. Direct and indirect routes are key persuasion strategies.

4. Persuasion is often incremental.

5. Persuasion through persuasive systems should always be open.

6. Persuasive systems should aim at unobtrusiveness.

7. Persuasive systems should aim at being both useful and easy to use.

The first postulate explains that all systems have some level of persuasion built in, regardless of whether there has been a deliberate intention to persuade attitudes or behaviours. This is because all systems are designed to encourage users to perform a certain task and so the system will be designed to facilitate those behaviours. The second postulate involves getting users to commit to a behaviour as this creates consistency, improving persuasion. The third and fourth postulates refer to the method of delivery that persuasion can take, which can be explicitly brought to the attention of users (direct) or more subtly integrated in how the system operates (indirect). Both cases should be carried out incrementally, with persuasion taking place over time. The fifth postulate is concerned with honesty, and if followed, reduces the likelihood that users will feel misled or coerced in altering their attitudes or behaviour. Designers should make it clear who they are and what they intend to persuade the user to do. Finally, the sixth and seventh postulates are primarily concerned with the design of the system features. A persuasive system should function at the times when the user needs the support, which is the sixth postulate of being unobtrusive. Logically, while the system is supporting the user, it should provide a pleasant user experience in order to be useful.

2.5.2 Phase 2: Persuasion context

The second phase of the PSD model involves analysing the persuasion context and contains three aspects for the way in which persuasion occurs: the intent, the event and the strategy. Analysing the intent primarily involves defining who is the persuader and the individual or group being persuaded. The event is the instance in which persuasion occurs, and needs to take into consideration what the goals of the individual being persuaded are. The event can be
further broken down into the *use*, *user* and *technology* contexts. Each of these has a number of contributing factors (Halttu et al. 2015). The *use* is situational and includes factors related to personal, physical, privacy and task-related of using the system. The *user* context is at a more individual user level and requires thought about personality and social factors related to persuasion. The technology context covers the role service and device factors play in supporting the event of persuasion. Finally, the strategy is the route in which the persuasion will be channelled through by means of a message.

### 2.5.3 Phase 3: Designing system qualities

The final phase of the PSD model is analysing the design of the system features that implement various persuasive elements. These can be categorised into four principles of support: primary task, dialogue, credibility and social. Primary task support works by helping users complete their main objective. Dialogue support is concerned with improving the human-computer interaction. Credibility support is designed to improve users’ perception of a system and to ensure that they do not feel manipulated or coerced. Finally, social support leverages the human relationships that compel people to behave in certain ways. Each of these principles can be broken down into specific methods of persuasion. A summary explanation of each of these can be found in Table 3.

*Table 3: Principles of the PSD model (adapted from Oinas-Kukkonen and Harjumaa (2008))*

<table>
<thead>
<tr>
<th>Principle</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary task support</strong></td>
<td></td>
</tr>
<tr>
<td>Reduction</td>
<td>Reducing complex behaviour into simple tasks, increasing benefit/cost ratio of a behaviour.</td>
</tr>
<tr>
<td>Tunnelling</td>
<td>Guiding users through a process or experience.</td>
</tr>
<tr>
<td>Tailoring</td>
<td>Providing information related to potential needs, interests, personality, usage context or other factors.</td>
</tr>
<tr>
<td>Personalisation</td>
<td>Personalising content or services.</td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>Providing the ability to track one’s own performance or progress in achieving goals.</td>
</tr>
<tr>
<td>Simulation</td>
<td>Providing the ability to observe the link between cause and effect in behaviour.</td>
</tr>
<tr>
<td>Rehearsal</td>
<td>Providing means to rehearse a behaviour.</td>
</tr>
<tr>
<td><strong>Dialogue support</strong></td>
<td></td>
</tr>
<tr>
<td>Praise</td>
<td>Providing positive feedback via words, images, symbols or sounds.</td>
</tr>
<tr>
<td>Principle</td>
<td>Definition</td>
</tr>
<tr>
<td>--------------------</td>
<td>------------------------------------------------------</td>
</tr>
<tr>
<td>Rewards</td>
<td>Giving credit for performing a target behaviour.</td>
</tr>
<tr>
<td>Reminders</td>
<td>Reminding users of their target behaviour.</td>
</tr>
<tr>
<td>Suggestion</td>
<td>Suggesting to users to perform certain behaviours.</td>
</tr>
<tr>
<td>Similarity</td>
<td>Imitating the user in a meaningful way.</td>
</tr>
<tr>
<td>Liking</td>
<td>Making the system visually appealing.</td>
</tr>
<tr>
<td>Social role</td>
<td>Adopting a social role that is relevant to the user.</td>
</tr>
<tr>
<td><strong>Credibility support</strong></td>
<td></td>
</tr>
<tr>
<td>Trustworthiness</td>
<td>Ensuring information in the system is truthful, fair and unbiased.</td>
</tr>
<tr>
<td>Expertise</td>
<td>Demonstrating knowledge, experience and competence.</td>
</tr>
<tr>
<td>Surface credibility</td>
<td>Imparting an impression of the system with a competent look and feel.</td>
</tr>
<tr>
<td>Real-world feel</td>
<td>Providing information about the organisation and actual people behind the system should be provided.</td>
</tr>
<tr>
<td>Authority</td>
<td>Referring to people in authority in the system.</td>
</tr>
<tr>
<td>Third-party endorsements</td>
<td>Having an endorsement from a reputable external source.</td>
</tr>
<tr>
<td>Verifiability</td>
<td>Ensuring content in the system should be easily verified via external sources.</td>
</tr>
<tr>
<td><strong>Social support</strong></td>
<td></td>
</tr>
<tr>
<td>Social learning</td>
<td>Providing ability to observe other users in the system and their target behaviours.</td>
</tr>
<tr>
<td>Social comparison</td>
<td>Providing ability to compare one’s performance to others in the system.</td>
</tr>
<tr>
<td>Normative influence</td>
<td>Bringing users with similar goals together to increase likelihood of adopting target behaviour.</td>
</tr>
<tr>
<td>Social facilitation</td>
<td>Providing ability to discern others who are performing target behaviour along with the user.</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Allowing users to work together.</td>
</tr>
<tr>
<td>Competition</td>
<td>Allowing users to compete with one another.</td>
</tr>
<tr>
<td>Recognition</td>
<td>Providing public recognition for users who perform the target behaviour.</td>
</tr>
</tbody>
</table>

**2.6 Building a Persuasive System**

Building a persuasive system is complex as it requires guidance for two important aspects: targeting behaviour and technical development methodology. Addressing the difficulties of this process, Fogg (2009b) suggests eight steps that can be followed to improve successful
outcomes. The core principle of the design process is the idea that persuasive systems should only target a single behaviour to influence. Then, once the behaviour has successfully been altered, the design can build on that success and attempt to change other behaviours. If too many behaviours are being targeted for persuasion, then the persuasive message will be diluted as it will be difficult for the end user to understand and recognise which part of the system is attempting to persuade them to do what. At a high level, this is the approach most popular technology services have used. For example, both eBay and Amazon began with single behaviours they desired to influence: to purchase a product or bid on an item. The more advanced features and recommendations came later, when the platform and the user behaviours were more mature and well established. At a high level the model is broken down into two main stages. The first stage features four main steps:

1. Selecting a simple behaviour to target.
2. Selecting a receptive audience.
3. Identifying what is preventing the target behaviour from occurring.
4. Selecting an appropriate technology channel.

Overall, this stage addresses concerns with identifying the behaviour to target. The second stage deals more with the process of building the system, with the following steps:

5. Finding relevant examples of persuasive technology.
6. Imitating successful examples.
7. Testing and iterating the product.

The final step in the model is to expand on success, which is a result of the core principle to target only one behaviour at a time and then, once successful, target other behaviours by repeating the process again from step 1. Figure 11 provides an overview of the entire model.
The first step has already been conducted in this research as part of the problem analysis and research questions found in Chapter 1. That is, the behaviour that is being targeted is improving student engagement with coursework. The persuasive learning system used by students in this research only targets that particular behaviour. Second, the model suggests that designers elect a receptive audience. This is a particular challenge for higher education as it is difficult to state that students would be entirely receptive to a persuasive system that encourages them to better engage with coursework. However, they are choosing to study at this level, and so there is some presumed level of willingness to want to learn. To address this divide, the system needs to be available to students, but using it in its entirety may need to be optional. That is, students may not have a choice in which learning platform they use, but they may still complete their coursework without fully engaging with all of the persuasive
features in the system. This idea aligns with the persuasive design postulates stating that systems should be unobtrusive. The third step is to identify what is preventing the target behaviour from occurring. This has been addressed to some extent in Chapter 1 through the analysis and discussion of how work-life, or more accurately, work-study balance has impeded students’ ability to spend large amounts of time on studying. In step 4, the designer must select an appropriate technology channel. Given that this research is dealing with a persuasive information system, and the fact that students are online and mobile, web and mobile apps are appropriate technologies to target. At the conclusion of this step in the model, the behavioural aspects of what the designer intends to build have been completed, with the actual system development to follow.

Step 5 is covered by section 2.9 of this chapter. Interestingly, the main issues with motivation and ability faced in this research (students knowing they should build foundational skills but not willing to do so) is similar to problems faced in other domains. For example, eating healthily and exercising is something that many people are arguably aware of, yet few people behave in accordance with this knowledge. Therefore, it stands to reason that as per the FBM for building persuasive systems, there will be valuable lessons to learn from other persuasive system implementations (step 6). Finally, testing and iterating quickly is advised since, unlike traditional information systems, persuasive systems are almost entirely focused on the user. That is, a persuasive system is attempting to influence behaviour, which is a very personal trait. Involving the user in the design process by listening carefully to feedback and adjusting accordingly will help the designers build a more robust persuasive system. The need to implement updates and changes quickly in the system reflects the competing attention for use system builders have. In the case of higher education students, if the persuasive learning system does not meet student needs and appears to stagnate, then the likelihood of “hooking” the students into the system will be diminished, which is evidence of the hook model cycle breaking down. The final step in the model is to expand on success, which should only occur once all other steps have been completed. While this may slow the pace of innovation in PSD, outcomes of behaviour change need to be validated before new attempts at expanding a persuasive system’s influence can be implemented, to ensure that actual behaviour change is occurring.

The FBM provides the logical flow of how to build a persuasive system in terms of identifying the behaviours and following a rapid development cycle. However, a common
scenario may be that a system already exists and the requirement is to augment the persuasiveness of the system. The FBM does not provide guidance on how to approach this, particularly as the fourth step (select an appropriate technology channel) implies that an existing system has not been selected. Implementing persuasive system design principles into an existing system is possible, particularly as one of the postulates of PSD is that technology is influential. Hence, a design team can examine an existing system for pre-existing persuasive features and then develop new persuasive qualities that enhance the overall persuasiveness of the system. This has been carried out previously in the development of a personal health and wellbeing system (Harjumaa & Muuraiskangas 2013), where the designers followed the process outlined in Figure 12. This design process is of particular interest to this thesis since it does not aim to create an entirely new learning platform but instead assess existing DLE for their inherent persuasiveness and augment these.
In summary, the Fogg eight-step model of designing for persuasion provides guidance for the overall research design, while the Harjumaa and Muuraiskangas (2013) model provides
direction for the implementation aspect of this research. Following established processes for building a persuasive system is important to ensure that the system will be reliable. However, like all technology, the system needs to be built for a purpose and to support what the user actually does. In the case of this thesis, assisting students with their learning process is the primary goal of implementing such a system, which is why it is important to review the relationship that technology has with teaching and learning practices.

2.7 Learning and Teaching

Understanding how students learn and the ways they can be taught needs to underpin the design of a persuasive learning system in order to ensure it assists with improving learning outcomes. Technology has played an important role in evolving how teaching is delivered and learning resources are consumed by students. High-bandwidth and always-available internet connections coupled with mobile computing devices have allowed students greater access and opportunities to learn. Historically, computers have given rise to e-learning: the use of computer technology to augment traditional learning practices (Hall & LeCavalier 2000). With the proliferation of mobile devices and integration into the learning process, e-learning evolved to m-learning. The convergence of desktop and mobile computing, as well as persistent internet connections, has made computing devices ubiquitous. This ubiquity has permeated education, with the term “u-learning” describing the challenge to the traditional approach of fixed teaching and learning spaces by enabling students to learn at any time or location they desire (Jeong & Hong 2013). It has been hypothesised that this new approach to teaching and learning will lead to students being more involved in their learning process (Marinagi, Skourlas & Belsis 2013), which is the long term goal of this research.

As mentioned in Chapter 1, the ubiquity of technology enables the potential to persuade people, and so does ubiquitous learning. It has been argued that teaching has naturally always involved persuasion because a student has pre-existing notions of understanding that need to be challenged to further their knowledge (Fives & Alexander 2001). Although persuasion may have been present always, it has only been highlighted recently with the advent of the term “teaching as persuasion” (Alexander et al. 2002; Murphy 2001). The purpose of teaching as persuasion is to encourage instructors to frame their view of the learning environment through the lens of persuasion. When considered from this perspective, it is evident that in order to change students’ preconceived ideas, credibility should be strongly implemented in a learning system (Lucero et al. 2006; Mintz & Aagaard 2012). While
instructors play a key role in the learning environment, it is also important to understand how students learn in that environment. As a result of the technological evolution described earlier, new approaches for facilitating learning have been developed. Three important methods the following sections discuss are self-directed learning, just-in-time teaching and micro-learning.

### 2.7.1 Self-directed learning

In higher education, there is an implied expectation that students who attend university are there because they want to learn. This is in part due to the traditional view that students who attend university are “academic elites” and are highly motivated to advance their skills and knowledge in their chosen field of practice. This type of motivation is intrinsic because the desire to engage with the learning process stems from within and highly motivated students are likely to want to take control of their learning process. Such students, who are willing and able to manage their study and take responsibility for their learning outcomes, are known as self-directed learners (Garrison 1997). However, students cannot simply be classified under the binary division of those who are self-directed and those who are not, but instead should be considered across a spectrum. The staged self-directed learning model (Grow 1991) outlines how students can range from being completely dependent on others through to being entirely self-directed. There are four types of learners according to the model:

1. Dependant
2. Interested
3. Involved
4. Self-directed

A dependant learner relies heavily on external regulation from people such as a coach or authority figures providing immediate feedback. This is not necessarily a negative trait, but the model suggests it can limit students’ potential. An interested learner is willing to engage; however, instructors provide most of the motivational triggers to perform actions. This type of learner is capable of being persuaded to begin taking control of their learning. An involved learner means the role of the instructor is that of a facilitator that guides the learning process, while students actively explore avenues of interest. The self-directed or “ideal” learner takes
full control of the learning process. They view the instructor as a consultant that they may refer to for advice or assistance when required. Table 4 summarises these types of learners.

Table 4: Self-directed learning stages (reproduced from Grow (1991))

<table>
<thead>
<tr>
<th>Stage</th>
<th>Type of Student</th>
<th>Perceived Role of Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dependent</td>
<td>Authority, coach</td>
</tr>
<tr>
<td>2</td>
<td>Interested</td>
<td>Motivator, guide</td>
</tr>
<tr>
<td>3</td>
<td>Involved</td>
<td>Facilitator</td>
</tr>
<tr>
<td>4</td>
<td>Self-directed</td>
<td>Consultant, delegator</td>
</tr>
</tbody>
</table>

Observing the trends of current students, it can be argued that most fall between dependent and interested. A proportion of students in higher education expect the instructor to provide direction on what to learn and immediate feedback on tasks and assessments that are completed. Others may be willing to find the direction themselves, but expect instructors to motivate them to continue through a course. Some students would likely be at the stage of being involved, although this would be rare. Fewer still would be entirely self-directed. With a large number of students in the earlier stages of self-directed learning, and the possibility of persuading second-stage students, a persuasive system has great potential to assist students in progressing through to the higher-level stages. In particular, a learning system that can automate the lower-level requirements of direction and motivation can free instructors to take on the higher-level functions of being facilitators and consultants. However, assuming that students want to become self-directed may be misguided, particularly for those in fields that are constantly evolving. Instead, students may prefer to be at the involved stage and develop the knowledge and skills they require in a just-in-time manner.

2.7.2 Just-in-time teaching

Similar to self-directed learning, technology has supported the concept of just-in-time teaching (Gavrin 2006). This pedagogy applies the principles of just-in-time manufacturing (Monden 1998) to learning by providing students with learning activities at the time they require it. One of the motivations for developing this method of teaching arose from students in the military being under immense time pressure to quickly learn required skills (Novak et al. 1998). To improve learning efficiency, students are instructed to prepare prior to attending class and class time is used to foster discussion, creating a feedback loop between students’ personal learning and the on-site learning environment. This results in lectures being more
interactive (Prince & Felder 2006). Improving interactivity and retaining interest in study away from the classroom are two aspects that this thesis is particularly concerned with. Hence, it will be prudent to evaluate the DLE selected later in this research against this philosophy. Another benefit of implementing just-in-time teaching is that course content does not need to be drastically altered to fit the teaching style. Instead, existing learning systems could be converted to persuasive learning systems that utilise the just-in-time teaching philosophy. To provide the correct activity for learning at a specific time (thereby enabling just-in-time teaching), content will need to be divided into smaller pieces, which connects with the concept of micro-learning.

2.7.3 Micro-learning

As stated, the proliferation of mobile devices has created opportunities for learning. People naturally make use of their mobile device to learn each time they search the web for something they want to know more about. Typically, small pieces of information are being sought for that moment in time (which follows the just-in-time teaching philosophy). This highlights an important component required for mobile devices to be effective for learning: the content needs to be small and easy to consume. The process is called micro-learning (Kovachev et al. 2011). Although mobile devices lend themselves neatly to the concept of micro-learning, it is not strictly limited to these devices and has been applied in desktops that present users with small learning activities on a screensaver (Bruck, Motiwalla & Foerster 2012). The wide applicability of micro-learning to both desktops and mobile devices is useful to this research by implying that all devices in the learning environment can be used to support micro-learning. Micro-learning differs to self-directed learning and just-in-time teaching in that it is not a standalone pedagogy, but can be used to support both those pedagogies. The bite-sized nature of micro-learning artefacts allows students to take control of when, where and how many learning activities they consume at a time. In contrast to micro-learning, allowing students to consume as much learning content as they desire could lead to binge-learning. This is where students consume all of a course’s material in a short amount of time, similar to how entertainment services such as Netflix\(^\text{11}\) or Spotify\(^\text{12}\) can be consumed (Dodd 2015; Powley 2015). Compressing the time spent studying a course may be

\(^{11}\) http://www.netflix.com
\(^{12}\) http://www.spotify.com
useful to students who are time limited due to non-academic commitments. They can work through material when it suits them, making the learning process less obtrusive.

All of these learning and teaching theories aim to improve the likelihood of completing coursework; however, they only describe the end goal of learning, which is how to get students to behave in an ideal way. Self-directed learning, just-in-time teaching and micro-learning are methods of instruction that are valuable for this thesis to select the most effective approach to persuade students and enable potential for improved learning outcomes. However, in order to affect behaviour, students’ current study behaviour must to be examined.

2.8 Measuring Learning Behaviour

Learning encompasses many different skills and abilities, and many study behaviours have either positive or negative impacts on learning performance. Previous research has sought to identify and categorise many study behaviours and strategies students typically adopt (Fitkov-Norris & Yeghiazarian 2013). Two scales resulting from this previous work are LASSI (Learning And Study Strategies Index) and MSLQ. LASSI consists of 80 items categorised under skill, will and self-regulation scales. These scales are then further divided into subscales. MSLQ consists of 81 items broadly categorised as part of either the motivation or learning strategies scales (Pintrich 1991). Those scales are then divided into two further levels of subscales. (Refer to Table 5 for a breakdown of the scales and subscales of the MSLQ. Definitions of each scale can be found in Appendix A. Both instruments serve a similar purpose, which is to assess the learning strategies employed by students.
Table 5: MSLQ scales and subscales (reproduced from Pintrich (1991))

<table>
<thead>
<tr>
<th>Learning Strategies Scales</th>
<th>Motivation Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scale</strong></td>
<td><strong>Subscale</strong></td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td>Intrinsic goal orientation</td>
</tr>
<tr>
<td></td>
<td>Extrinsic goal orientation</td>
</tr>
<tr>
<td></td>
<td>Task value</td>
</tr>
<tr>
<td><strong>Expectancy</strong></td>
<td>Control of learning beliefs</td>
</tr>
<tr>
<td></td>
<td>Self-efficacy</td>
</tr>
<tr>
<td><strong>Affective</strong></td>
<td>Test anxiety</td>
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<td></td>
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</tbody>
</table>

Although both questionnaires measure similar concepts and have been shown to be reliable (Obiekwe 2000), an advantage of MSLQ over LASSI is that there is no implied internal model that must be used to interpret results. The MSLQ scales are also designed to be modular to allow a researcher to develop a model structure to fit the needs of a particular study (Pintrich 1991). This ability to customise the MSLQ makes it a suitable candidate for use in the present study, as this research is of an exploratory nature and requires greater freedom in interpreting the data collected.

Previous studies have attempted to analyse the latent structure of the MSLQ and provide a framework for investigators to use. One such study attempted to validate the MSLQ by performing confirmatory factor analysis on the general model presented by the MSLQ of the motivation and learning strategies scales, and all of the subscales. The model was refined, resulting in a model with a three-factor structure of expectancy, value and resource management (see Figure 13). Other studies have used a subset of the lower-level subscales available to develop a relationship model (as shown in Figure 14). These examples demonstrate the versatility and adaptability of the MSLQ. Although the purpose of this thesis is to identify specific behaviours for PSD, the broader scales in which the items belong are also analysed. This enables identification of the broader factors that lead to higher performance among students. This can be used in later research to identify the type of educational environment that is conducive to high performance and more likely to successfully apply the principles of persuasion to instil good study behaviours in students.
The models in Figures 13 and 14 provide a baseline against which this thesis’s results can be compared.

![Figure 13: MSLQ three-factor model (reproduced from Hilpert et al. (2013))](image1)

2.8.1 Bloom’s taxonomy

The link between study behaviour scales and pedagogy is strengthened by observing how they relate to Bloom’s (1956) taxonomy for learning (Bloom 1956), which has informed the design of learning objectives that lead to higher-order levels of thinking in students (Heirdsfield et al. 2011). It is possible to break down learning into several stages that range
from absolute and basic types of learning proficiency to more abstract types. Ideally, an individual would follow an educational path that includes:

1. Acquiring knowledge
2. Comprehending what the information means
3. Applying knowledge in practice
4. Being able to use knowledge to analyse problems
5. Combining different aspects of knowledge to synthesise new knowledge
6. Being able to evaluate information

These six steps define the high-level categories of Bloom’s original taxonomy for developing learning objectives. The taxonomy’s purpose is to enable instructors to devise learning objectives in accordance with this scale in order to encourage students to adopt higher levels of thinking. Since its inception, the taxonomy has evolved (Anderson, Krathwohl & Bloom 2001) to:

1. Remember
2. Understand
3. Apply
4. Analyse
5. Evaluate
6. Create

The original taxonomy suggests that progression through each stage is ideally linear, whereas the revised model allows for flexibility while progressing from application to analysing, evaluating or creating. This difference is illustrated in Figures Figure 15 and Figure 16.
Bloom’s taxonomy is a useful tool for assessing student study behaviour because behaviour can exhibit different levels of the taxonomy. For instance, students who attempt last-minute studying before an examination (colloquially called “cramming”) are behaving at the remember level of the taxonomy. They do not understand the content, and are simply trying to remember enough to pass the assessment. PSD should be mindful not to limit influencing study behaviour to reinforcing the low levels of Bloom’s taxonomy. Instead, persuasive systems have the potential to elevate students to the higher levels by persuading students to follow the behaviours of students who are at the higher levels.
2.9 Related Work

One of the key principles in Fogg’s eight-step design is to build on past successes. In accordance with this principle, this section examines related work in the area of PSD. By examining the use of PSD it allows for greater depth of understanding of the strengths and weaknesses of the model by analysing how it was applied and the implications of its use. Disciplines other than education that are examined include computer security, health and environment. An issue these areas have in common with education as opposed to other domains is that there is an underlying issue with behavioural compliance. That is, these fields face the challenge of persuading individuals who are often aware of what they should be doing, and yet are not behaving accordingly. This is unlike domains such as economics which deals with influencing consumer behaviour without the consumer being aware of what the optimal behaviour might be.

2.9.1 Computer security

One example of a persuasive technology relevant to this thesis is the Persuasive Text Passwords system designed to persuade users to create stronger passwords (Forget et al. 2008). As with study behaviours, people are typically aware that they should create strong passwords, but lack effort and motivation to do so. Forget et al. were able to influence users to repeatedly form better passwords by using a method called “tunnelling”. This involves guiding the user through the process they wish to influence in an incremental way. This may be a useful technique to encourage good study behaviours, particularly for students who are not aware of what a good study behaviour might entail.

2.9.2 Health

Another relevant persuasive technology example targets habitual consumption of carbonated beverages. One study attempted to assist people to reduce their intake by developing a system where participants can log their consumption and weight and provide feedback (Langrial et al. 2012). The key persuasive element in the system is reminders: the system emails participants each morning to prompt them to enter their consumption and weight. The results showed that by the end of the study period, people were voluntarily entering data without being prompted. One reminder a day was enough to encourage this effect. A separate study related to sleep deprivation also used persuasive reminders in three distinct ways: to praise, to
prompt practising of skills and to provide awareness of upcoming rehearsal modules and found that participants responded positively to those messages (Langrial et al. 2014). These are relevant to this thesis because students are likely to need reminding of the tasks they need to complete for their course, especially given their typically busy schedule of work and study. When reminders are combined with self-monitoring and tunnelling, the persuasive effect can be quite substantial, which was the finding in a study where participants used a web-based system to assist with preventing metabolic syndrome (Karppinen et al. 2016). However, it should be noted that the carbonated beverage participants were willing and ready to reduce their consumption, whereas students may not be so motivated to improve their study behaviour.

Another relevant study investigated the use of a system called Flowie to encourage elderly people to walk using context-aware notifications to prompt them to exercise (Albaina et al. 2009). The results showed the system increased motivation to exercise, but actual measured physical activity did not change significantly. Participants reported that this may have been due to the limited context awareness of the system, as poor weather often stopped an otherwise motivated individual from achieving their goal of going for a walk. This case is illustrative of what the FBM covers (issues of motivation and ability for successful triggers), and demonstrates why the FBM is useful in analysing the barriers to persuasive systems being effective. Reminders helped to improve motivation to exercise, but the weather (and the system’s failure to understand that it was raining) hampered the person’s ability to complete the action. Hence, the reminder trigger failed to result in a change in actual behaviour.

Studies have incorporated goal setting to encourage physical exercise. In one study using heart rate monitors, users were given the option of selecting a goal for weight loss or to improve or maximise fitness. The results showed that goal setting supported by tracking performance, social roles and overall perceived credibility had significant impact on behavioural influence (Harjumaa, Segerståhl & Oinas-Kukkonen 2009). In another study, participants used the UbiFit system (Consolvo et al. 2009), which involves weekly exercise goals being set in one of five ways:

1. Self-set by the individual

2. Assigned (in line with national recommendations, a fitness expert or a medical expert)
3. Participatory (a fitness or medical expert works with the individual to set the goal)

4. Guided by a fitness expert

5. Group-set by either strangers or the person’s social network

The group-set goal means that if one person in the group fails to reach the goal, the entire group fails. A mobile phone app provides a “glanceable display” for the exercise routines for the week so that the user can be reminded of what they need to do to achieve their goal. Goal setting for physical fitness has implications for potential persuasive learning systems since goal setting is also common in educational theory. The results of the study showed that participants preferred some kind of “expert” assigning them goals, rather than a regular standard. This implies that students may be more receptive to goals being set for them in a system by instructors, rather than by a government body. This should be considered in the design of the persuasive system for this thesis. The negative response to the group-set goal could also be true for students: they may not completely trust this responsibility to fellow classmates, which would lead to a reduction in the rate of voluntary participation for that type of goal setting.

2.9.3 Environment

Another relevant example of persuasive design can be found in the Persuasive Trash Cans study (De Kort, McCalley & Midden 2008). The study aimed to uncover the differences between implicit and explicit activation of behavioural norms by placing signs with text to elicit varying types of activation. It was found that explicit activation (rather than implicit) was clearly more likely to result in a change of behaviour, even if the implicit norm for the individual was to avoid littering. This too draws parallels to study behaviour issues in that a student’s norm may be to study properly, but unless there is explicit activation of that behaviour they are less likely to do so. Therefore, a persuasive learning system should make the study behaviour explicitly aware to students. Finally, visual feedback has also been shown to be an effective tool to influence behaviour. The Waterbot system is designed to improve safety, hygiene and water conservation at the sink by providing alternative types of feedback including sounds and lighting (Arroyo, Bonanni & Selker 2005). Participants responded positively to the more meaningful feedback. This finding can be applied to the persuasive design in this thesis, particularly for providing students with feedback on their learning.
2.9.4 PSD model for evaluation

One of the strengths of the PSD is that it can be used for both designing and evaluating persuasive systems (Oinas-Kukkonen & Harjumaa 2008). One instance of where the PSD was used as an evaluation tool was in assessing mobile apps designed to improve personal wellbeing. (Langrial et al. 2012) analysed each feature of various wellbeing apps and recorded whether they could be categorised under the PSD principle components. The team initially conducted individual reviews and then combined their assessments. To ensure the results were more rigorous, at least three out of the four team members needed to agree that a feature met the criteria to be classified on the PSD scale. A similar study evaluated the persuasiveness of various weight loss websites and found common strengths and weakness in the persuasiveness of these types of systems (Lehto & Oinas-Kukkonen 2010). Underutilised system characteristics were found, including tailoring and rewards, and social support in general. The study also highlighted the weak use of dialogue support and the effective use of expert moderated social features. The PSD has also been used to assess software designed to assist with medication management (Win et al. 2017) In that study, it was found that most systems provided primary task and dialogue support, while social support was generally not strongly implemented. Collectively, these studies demonstrate the ability of the PSD to diagnose issues with and provide insight into the levels of persuasion in a system.

2.10 Summary

Persuasive systems encompass many different aspects. To design an influential system, an understanding of human behaviour and technological capability is required. While individuals can be persuaded in many different ways, technology simplifies the process and makes it much more scalable. Influencing behaviour is important because behaviour change is not likely to occur without it due to the complexities involved. Although it is simpler to categorise behaviour in discrete stages, the reality is that behaviour can be erratic and responds to outside triggers. Replacing these triggers from negative or unwanted sources with a deliberately designed system is a key objective of this thesis. In the context of applying the persuasive systems principles to higher education, it is also important to understand how students learn, which is why this chapter covered the various learning theories that will be central to the analysis and design of the persuasive learning system. This chapter also covered other examples of how persuasive technology has been applied to solve problems of human behaviour. Password management and health and fitness persuasive designs were found to
address similar problems to those of education, in that users knew what they should be doing but lacked motivation or ability and were therefore never triggered.
Chapter 3: Methodology

3.1 Overview

To address the aim of this research—to develop a systematic approach for building persuasive DLE—this chapter presents a methodology of three phases designed in response to the three research questions. They are: analysis of the current behavioural trends of students, selecting a learning platform and designing persuasive features, and identifying the persuasive factors and postulates based on a real-world DLE implementation. The intention is to obtain results that not only answer the respective research questions but also inform the subsequent phases, as each phase extends from the last. The results of each phase will have theoretical and practical implications for the two main aspects of persuasive systems philosophy: human behaviour and system design.

3.2 Research Design

There are two aspects of persuasive system design that need to be evaluated in this research. Firstly, the impact that learning behaviours have on academic performance. Secondly, the student experience of using a persuasive learning system. To collect data to measure these two aspects, a mixed-methods approach is used. Individually, quantitative data is suited to analysing cause-and-effect, and qualitative data is suited to explaining complex problems, particularly involving people’s personal experiences (Johnson & Onwuegbuzie 2004). Hence, a single quantitative or qualitative methodology would not suffice for this research as the two aspects described earlier require both types of data to be adequately analysed. More specifically, quantitative and qualitative data will be required at different times, as this research is comprised of three phases (see Section 0). Mixed-methods research that has distinct phases can be executed in a number of ways, including sequentially or in parallel (Creswell 2013; Teddlie & Tashakkori 2006). In sequential mixed design, a developmental approach can be used where each phase builds on the previous and each subsequent phase is improved by using the inference garnered from earlier phases (Venkatesh, Brown & Bala 2013). This research uses sequential mixed design as it is not possible to simultaneously conduct data collection and analysis about current student learning behaviours and also design and evaluate the effect of persuasive design on students.
Exploring the individual types of analyses to be performed, phase 1 is designed to uncover study behaviours of students in general and measure those having the greatest impact on learning performance. In this phase, students are surveyed through an online questionnaire that is then used to construct MLR models. These models are used in phase 2, which involves assessing existing DLE by conducting an expert analysis focus group and designing and implementing software to encourage the behaviours previously identified. The resulting system is used as the software platform from which persuasive factors and postulates are identified. In phase 3, students are surveyed about their experience of using the persuasive learning system, and are also invited to take part in individual interviews. The purpose of using mixed-methods data collection is to identify factors through factor analysis of the survey data, and to then provide depth of understanding of these factors using the qualitative interview data, which can then be used to construct general postulates. A summary of the methodology is shown in Figure 17, and includes the data collection and sub-processes undertaken. Lower-level details are explained in subsequent sections.
Figure 17: Research design phases
3.3 Phase 1—Behavioural Analysis

Phase 1 addresses the first research question:

1. What impact does existing student learning behaviours and strategies have on academic performance?

To answer this, undergraduate student behaviours and what impact those behaviours have on academic performance are modelled. Measuring behaviour against this criterion is important because the aim of a useful learning system should be to encourage students to improve academically and not to reinforce existing behaviours that may be detrimental. While this thesis does not explicitly measure actual behaviour change or impacts on grades, the persuasiveness of the system needs to be evaluated in the context of the system’s ability to influence those types of behaviours. Hence, positive study behaviours need to be identified in this phase, which is why an online survey targeting current students and alumni is used to identify those that have the greatest impact on academic performance. The questions for the survey are sourced from the MSLQ instrument, with some modification. This section outlines the details of those modifications, as well as the statistical approach used to determine the most important study behaviours.

3.3.1 Instrument design

The survey instrument consists of two main sections. The first section establishes the respondents’ demographic details: age, sex, degrees undertaken, current student status and predominant academic load. The second section features the entire MSLQ questionnaire with some minor modifications. There are two main reasons why modifications are made. First, the MSLQ questions are originally intended to be answered in relation to one specific course a participant is undertaking, whereas this thesis is concerned about behaviour at the program level. Second, the standard survey does not enquire about academic achievement because it is intended to be administered in a single class, so the details of students’ academic performance are readily available to instructors. Data on students’ past academic grades are not available for analysis in this research, given the broader scope of assessing behaviour for study related to university degrees in general. To address the first issue, some questions in the administered survey were reworded to make them more general, which is possible to do without affecting instrument validity (Rotgans & Schmidt 2010). Care was taken not to alter
the original meaning. Examples of two altered questions are shown in Table 6. The complete questionnaire can be found in Appendix B.

Table 6: Example of MSLQ question generalisation

<table>
<thead>
<tr>
<th>Original Question</th>
<th>Modified Question (Generalised)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting a good grade in this class is the most satisfying thing for me right now.</td>
<td>Getting a good grade is the most satisfying thing for me.</td>
</tr>
<tr>
<td>In a class like this, I prefer course material that arouses my curiosity, even if it is difficult to learn.</td>
<td>I prefer course material that arouses my curiosity, even if it is difficult to learn.</td>
</tr>
</tbody>
</table>

To address the lack of questions regarding academic performance, the following two questions were added to the survey instrument:

- How would you describe your academic performance as a student?
- How often did you receive high grades (of 80% or over) for assignments, exams or subjects overall?

The questions cover different dimensions of academic performance. The first enquires about students’ self-perception of their performance. The intention is to use responses to this question as a measure against the behaviours from the MSLQ to identify behavioural patterns that lead to students believing they are good performers. To provide a more uniform baseline from which respondents can answer, the second question asks for the frequency in obtaining results over a specific percentage value. The percentage level is set in accordance with the mastery learning theory, which suggests that receiving a grade of 80% or above indicates real understanding (Block & Burns 1976). Asking performance questions in terms of self-perception and result-based measurements allows for the possibility of identifying discrepancies between what students believe make them “good” and what actually leads to strong academic results. Respondents who perceive their performance to be poor or do not obtain high marks will also provide insights into what may be inhibiting their ability.

In the survey, respondents are instructed to answer using a five-point Likert scale, with options ranging from “very much disagree” to “very much agree” for the MSLQ items, excluding the two performance questions. Self-perceived performance ranges from “very poor” to “very good” and responses for how often did you receive high grades range from
“never” to “all of the time”. No restrictions are placed on the geographic location of respondents, thus offering greater flexibility in enquiring about performance given the differences in grading systems around the world.

3.3.2 Survey distribution

To maximise exposure, the online survey was distributed via Facebook and LinkedIn for a duration of eight weeks. A message was posted instructing potential respondents to fill in the survey and to also share the link in their friendship networks to encourage a “snowball effect” (Biernacki & Waldorf 1981). The demographics of all higher education students are diverse, and the snowball approach is a useful way of maximising the likelihood of obtaining a wide range of respondents (Penrod et al. 2003). Facebook was used because it is a popular choice for online social networking for undergraduate students. LinkedIn was used because there is an active community of alumni that regularly communicate with their former instructors at the university, increasing the odds of obtaining alumni respondents. That is not to suggest that Facebook only provides undergraduate respondents and LinkedIn only provides alumni respondents, only that they are more likely to do so. The purpose of targeting both students and alumni is to identify whether the immediate goal of graduating has an impact on what current students perceive their learning behaviour to be, in comparison with alumni who respond to the survey retrospectively.

3.3.3 Data analysis

The collected data are analysed by testing each of the original MSLQ questions and both of the academic performance questions that were added to generate a model for both impactful behaviours on self-perceived performance as well as behaviours for results-based performance. The models are created in two steps; the first step reduces the number of items by statistical impact, and the second by construction of a MLR model. SPSS (2010) software is used because it features ALM that can be used to efficiently reduce the list in the first step of model creation. Both steps are detailed as follows.

3.3.3.1 Step 1: Automatic Linear Modelling

Performing exploratory linear modelling can be a time-consuming process, particularly when there are many items that can potentially be used. ALM helps the researcher test many individual linear models quickly, and provides a ranked list of variables and their impact
factors. ALM achieves this efficiency by automating the process of using the standard linear function by recursively testing every independent item against a single dependant item. To perform this test, the academic performance item is selected as the dependent variable, and all of the MSLQ items as independent variables. The software then tests every possible combination and produces a list of the variables with the largest impact. The software provides an accuracy measurement in the form of an adjusted $r^2$ value, expressed as a percentage. The top 10 variables are then used in the following step. The ALM feature automatically prepares the data for analysis, which involves date and time adjustment, measurement level adjustment, outlier handling, missing value handling and supervised merging (SPSS, 2010).

3.3.3.2 Step 2: Multiple Linear Regression

The resulting variables from the ALM are then used in the construction of several MLR models. The significance of each of the variables is assessed and any that do not fall within 0.05 significance are excluded. The MLR is performed once again with the reduced set of variables. This is repeated until all remaining variables are significant and within the acceptable Durban-Watson value range of between 1 and 3 (Field 2009). Final models should have between three and five variables that are significant. The items in the final models are then used in the second phase, where system features are designed and implemented to encourage students to adopt these behaviours.

3.4 Phase 2—Persuasive Feature Design and Implementation

Phase 2 of the research design centres on the design and implementation of a persuasive learning system in a university environment. There are two main outcomes for this phase: platform selection and feature design. This phase does not answer the second and third research questions directly, but serves as an important preliminary step by providing the persuasive learning system used for data collection in the final phase. To make this process more efficient, entirely new systems are not created; rather, two existing DLE are evaluated in order to select one as a candidate for experimentation. The two systems evaluated are Blackboard (a traditional DLE) and TTM (a next-generation DLE). The evaluation of inherent persuasion in DLE is based on how they rate against the PSD framework, which is currently the most comprehensive theory on persuasive systems. The analysis is carried out using an expert focus group, consisting of participants who are familiar with both Blackboard
and TTM, to ensure the results are as accurate as possible. The resulting candidate system of the expert analysis is then enhanced by implementing the positive learning behaviours in a manner that aligns with the PSD constructs. The final product of this process is a persuasive learning system that students use during a semester in a higher degree program. The following sections detail the expert analysis and enhancement process.

3.4.1 Expert analysis

To ensure that each system was evaluated appropriately using the PSD model, an expert analysis focus group was formed comprising three research team members (the author of this thesis and two supervisors), a research student and an undergraduate intern. The group provided different perspectives and experiences of using the systems. The two supervisors are academics who have used both Blackboard and TTM in the delivery of their courses, and have nine and 15 years of teaching experience, respectively. The student intern experienced both systems as a student. The author and student experienced Blackboard as students and were part of the development of the original version of TTM.

To perform the analysis, each item in the PSD is discussed in relation to both Blackboard and TTM until a consensus is reached on whether the system features that aspect of persuasion and in what way it implements it. The group takes into account the overall system design when assessing the features, as typical usage would involve interacting with several different features or design elements to create a persuasive effect. The analysis is recorded by one of the members of the research team in a table outlining the persuasive element and the feature or design trait that satisfies that criteria. This method was used by Lehto and Oinas-Kukkonen (2010) to evaluate the persuasiveness of weight loss systems, and was successful in identifying persuasive features and opportunities to improve the systems. Following the analysis, one system is selected as the basis on which further persuasive enhancements can be built and for measuring persuasion in phase 3.

3.4.2 Study behaviour persuasive implementation

With the learning system selected, the final process of phase 2 is to select the behaviours identified in phase 1 and identify existing or design new system features to encourage those behaviours in the system, if feasible. These system features are designed in accordance with corresponding PSD principles, such as reduction or personalisation. Behaviours that can be classified according to this scale are then implemented as features. The features may be web-
based, mobile-based or a combination of both. As an initial step, behaviours that are encouraged through features already implemented in the original design of the system are identified and not developed as new. Any remaining behaviours then have custom-designed system feature implementation in the learning platform, resulting in a final persuasive learning system that is used as the basis for students to experience phase 3.

3.5 Phase 3—Persuasive System Intervention

In the final phase of the research design, the persuasiveness of the system is evaluated using a mixed-methods approach to identify the persuasive factors, the relationship between the factors and general postulates for designing persuasive learning systems, culminating in the persuasive design philosophy. This phase answers the two remaining research questions:

2. How can persuasion in a learning system be modelled, and what factors enable it?

3. How can systems be designed to persuade students to better engage with their studies?

Identifying the factors that enable persuasion is important when analysing a persuasive system because there is considerable complexity involved, mostly due to the variable nature of human behaviour. Identifying factors highlights the most important areas to focus attention and effort on (Rockart & Sloan 1982). Traditionally, these are termed “critical success factors”, and their identification was popularised in the early decades of information systems development when managers struggled with the accelerating rate of technological change and wanted to know which areas should be given greater focus and attention in order to be competitive (Bullen & Rockart 1981; Daniel 1961). Critical success factors are particularly important in enterprise resource planning systems since such systems traditionally have high failure rates (Amid, Moalagh & Ravasan 2012; Somers, Nelson & Ragowsky 2000; Sumner 1999); critical success factors guide management in their decision-making process (Somers & Nelson 2001). The issues of complexity and change in early information systems and enterprise resource planning systems also arise in persuasive systems, and so identifying factors that affect persuasive learning system will have useful implications for research and practice.

The mixed-methods design used in this thesis is consistent with standard practice (Creswell 2013). There were two sequential collections of data and related analyses: the first quantitative and the second qualitative. A principal component analysis was performed on a
survey distributed to students. The construction of the relationships between these factors was completed qualitatively through thematic analysis of interviews with students regarding their usage of the system and thematic correlation analysis of the theme directly. The two datasets are mixed by embedding the qualitative data analysis within the quantitative analysis (Fetters, Curry & Creswell 2013). The quantitative analysis provides breadth while the qualitative component adds depth to the analysis.

3.5.1 Survey instrument design

A survey instrument was constructed to enquire into student demographic details, system usage and persuasive impact. The demographic details include gender, age, student type and study load. The system usage section enquires about aspects of the system, such as how often the student completes tasks, and tests and how often students use the system. Answers are given using a Likert scale. The persuasion questions are adapted from an aforementioned related study that surveyed users about a health-based behaviour change support system (Lehto, Oinas-Kukkonen & Drozd 2012). Lehto et al.’s survey consists of 21 questions covering six constructs: primary task support, dialogue support, perceived credibility, design aesthetics, perceived persuasiveness and unobtrusiveness. These constructs align with the constructs to be measured in this study and given its demonstrated reliability, is a suitable candidate to use as a survey instrument for this research. The questions are modified to suit the learning environment of the present study, with some rewording made in some cases. For example, “…provides me with a means to lose weight” is changed to “…provides me with a means to study”. A list of the modified questions can be found in Appendix C. All questions in the PSD evaluation section use a five-point Likert scale ranging from “very much agree” to “very much disagree”.

3.5.2 Interview instrument design

The interview instrument is designed to extract information about why the system was or was not persuasive to students’ learning throughout the semester. The instrument covers various areas: learning attitudes, system usage, evaluation of the impact the features had, the mobile component of the system and any other points of discussion that the participant wishes to raise. The first section provides some background on how the student typically thinks about their studying process, to gauge whether their study behaviours are already positive or not. This creates a baseline against which the responses in the later sections can be interpreted.
The second part of the instrument covers questions that are designed to understand the frequency and depth of use the student had with the system. Questions such as “How often did you complete tasks?” and “On average, how many attempts did you have on completing tests?” are used to prompt the respondent. The third group of questions asks specifically about features in the system, with an emphasis on what sort of impact those features had on their behaviour. This is designed to measure whether certain features are more persuasive than others and why. The final group of prepared questions enquires about the use of the mobile component of the system, with a focus on the role reminders play in triggering study behaviour.

The interviews follow a semi-structured format to ensure that the main areas of concern are discussed, while still allowing for open dialogue to provide a richer understanding of what students experienced. The researcher uses the questions to encourage discussion and to ask any follow-up questions. The answers to the feature impact questions form a core part of the analysis later in the phase.

**3.5.3 Survey data analysis**

A factor analysis is conducted on the PSD scale survey data to identify what enables persuasion in a learning system, which forms the main outcome of phase 3. The factors extracted represent the underlying theoretical constructs in the dataset (Henson & Roberts 2006). Given there is no known previous work on how many or what types of factors already exist, identifying general factors is an appropriate initial step (Fabrigar et al. 1999). The survey data consist of two categories: the PSD scale and the system usage data. The TTM usage section of the survey is analysed using descriptive statistics, as is the PSD scale section of the survey.

The main form of analysis used is factor analysis, performed by following the recommended method of Field (2009). Principal component analysis with direct oblimin rotation is used because it is well suited to extracting factors on data that measure human psychology constructs. Analysis on human behaviour is very unlikely to result in distinct factors with no cross-loading, as human beings are complex, and so principal component analysis with direct oblimin rotation accounts for that assumption. The factor analysis excludes cases listwise, sorts by size and suppresses values below 0.4 since these are deemed to be insignificant. All of the items are used to perform the analysis initially, to enable inspection of the correlation
matrix. Items with many low correlations or those that feature high correlation, indicating multicollinearity, are considered for removal. After removal of the insignificant items, the determinant is inspected to ensure it falls above the 0.00001 limit recommended to ensure there is no internal issue with multicollinearity in the model. The software then extracts factors with eigenvalues over 1. The resulting scree plot is inspected by checking for the point of inflection and validating that the appropriate number of factors were extracted. Finally, the items in each of the factors are analysed by considering the PSD construct the item originated from, as well as its individual meaning, in order to label the factor appropriately.

3.5.4 Interview data analysis

After persuasive factors are identified, a thematic analysis on the qualitative data collected from the student interviews is conducted. A thematic analysis involves describing a dataset in terms of the patterns that emerge from what is spoken (Braun & Clarke 2006). This is useful for this phase in two ways. First, the themes derived from the analysis can be used as a basic form of validation of the factors extracted from the survey data. That is, if the factors appear as themes without specifically being prompted by the facilitator, then this improves the likelihood that the factors exist. Second, the themes identified provide insight into the relationships between the factors, which is used to construct a general model for how persuasion operates in a learning system. A combination of the factor and thematic analyses is also used to identify postulates for designing successfully persuasive learning systems, thereby answering the third research question. Interview data are required in this process because evaluating persuasion in a learning system involves human behaviour. Without measuring behaviour directly, speaking with individuals who used the system can provide meaningful insights into the effect the persuasive features have on study behaviour. The thematic analysis follows an inductive approach, which involves building themes or theories as a result of the coding process, rather than testing the data against an existing theory or structure (Burnard et al. 2008). This is ideal for this analysis as it is exploratory in nature and there is no theory or framework explicitly being tested against the data. While the PSD framework is central to this research, it is not being tested for validity, but is used to guide the research design and factor analysis.

The collected interview data are transcribed and entered into the NVivo software package where coding is completed in a number of phases (Saldana 2009):
1. **Pre-coding**: identifies potentially useful segments of the transcript.

2. **Descriptive coding**: codes the transcript using descriptions of what is being discussed.

3. **Categorising**: groups the codes into related categories.

4. **Final coding**: refines the codes into themes.

First, pre-coding is conducted by highlighting answers to questions that are likely to contain useful information in order to focus on meaningful passages during the following phases. Then, the data are analysed using descriptive codes as part of the first pass of analysis; for example, a discussion about assignment results can be descriptively coded as “grades”. Descriptive codes also take the form of the PSD principles, where participant discussion on the ease of completing coursework is coded as “reduction”. In the third step, the individual codes determined to be logically related such as “grades” and “assignments” are categorised at their high-level meaning, which in this example may be “assessment”. This is repeated for the low-level PSD constructs, with “reduction” and “self-monitoring” grouped as “primary task support”. Using a combination of general descriptive terms and the PSD constructs assists in identifying general postulates for persuasive learning systems by associating general learning concepts with PSD implementations. The associations are constructed in part by performing a correlation analysis with NVivo. This technique involves analysing word clusters that correlate between themes. An example of the output is shown in Figure 18.

![Example of an NVivo word cluster correlation chart](image)

*Figure 18: Example of an NVivo word cluster correlation chart*
In the fourth and final step of the thematic analysis, the codes and correlation output are assessed and discussed using the survey factors as broad categories from which broad themes can be deduced. These themes guide discussion exploring the impact the system had on students, culminating in the construction of postulates for designing a persuasive learning system based on students’ experiences.

3.5.5 Why postulates?

One of the main contributions of this study is the identification of postulates for designing a persuasive learning system. These postulates also provide guidance for other system designers who are intending on making a learning system more persuasive. Traditionally, theories are developed to help guide high-level development of systems. This thesis, however, is exploratory in nature since the application of a persuasive design framework to the DLE is a new research area and there is little empirical evidence from which to develop hypotheses. Hence, it is prudent to use a generalised persuasive systems theory that has been successfully applied elsewhere (such as the PSD framework) and attempt to draw out high-level findings for the education domain. These findings can then be used for future persuasive learning systems theory development. The terms “convention”, “doctrine”, “principle” and “postulate” are at times used interchangeably, but not all these terms refer to the same aspect of theory development. Early accounting theory also faced this issue, with one study (Vatter 1963) defining the terms as follows:

- **Convention**: A general agreement on usage and patterns.
- **Doctrine**: Ideas or teachings about the practice.
- **Principle**: Generalisations about how to reach objectives.
- **Postulate**: Explanations for the structure of a theory.

Conventions and doctrines should logically be developed when a theory has matured and its applicability tested and validated, so these terms are not appropriate for this thesis. The term “principle” is frequently used when discussing system design, and is suitable when there is a particular objective or purpose to which it can be applied. Given that persuasive systems deal with a variable component (the user behaviour to be influenced), a set of principles would not be reliable since only one behaviour is being targeted in this research. In contrast, a postulate
enhances and explains a theory in general, much like the postulates that exist in the current PSD framework, and aligns with the goal of this research to provide improved understanding of how the PSD applies to education.

### 3.6 Summary

In this chapter, the three-phase methodology of the research was outlined. In phase 1, preliminary analysis of the behavioural patterns of undergraduate students is conducted by using a modified survey instrument to measure the effect of behaviours on self-reported academic performance. These results are then used to inform the development of a persuasive system that is designed and implemented in phase 2. Phase 3 involves students using the persuasive system and measuring its overall level of persuasiveness through a survey and individual interviews. The survey and interviews provide better understanding of the reasons why the system is perceived as persuasive and identify the persuasive factors that lead to this outcome. The factors are modelled and used to identify design postulates that can be employed by future persuasive e-learning system designers. The following chapter presents the results and discusses the findings of phase 1.
Chapter 4: Behavioural Analysis†

4.1 Overview

This chapter presents phase 1 of the research. Two models—a perceived and a results-based model—were constructed to measure the impact certain study behaviours have on two dimensions of academic performance. The models were divided into current students and alumni to investigate differences in behavioural patterns for students currently studying versus those who already completed degrees and were deemed “successful”. The findings from this phase are used in subsequent phases, providing the behavioural platform from which persuasive features can be built.

4.2 Survey Results

There were 84 respondents to the survey (described in section 3.3.1), yielding 67 complete usable samples. The data were representative of younger-aged students (both current student and alumni), with respondents generally aged between 18 and 29, and gender was evenly distributed (ABS 2013; DET 2016). Table 7 details the descriptive statistics of the usable dataset.

Table 7: Study strategy respondents’ descriptive statistics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>34</td>
<td>50.75</td>
</tr>
<tr>
<td>Female</td>
<td>33</td>
<td>49.25</td>
</tr>
<tr>
<td><strong>Age group</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18–29</td>
<td>60</td>
<td>89.55</td>
</tr>
<tr>
<td>30–39</td>
<td>6</td>
<td>8.95</td>
</tr>
<tr>
<td>40–49</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50–59</td>
<td>1</td>
<td>1.50</td>
</tr>
<tr>
<td>60 and over</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Mode of study</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>62</td>
<td>92.54</td>
</tr>
<tr>
<td>Part-time</td>
<td>5</td>
<td>7.46</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current student</td>
<td>28</td>
<td>41.79</td>
</tr>
<tr>
<td>Alumnus</td>
<td>39</td>
<td>58.21</td>
</tr>
</tbody>
</table>

The data appeared to be biased towards higher-performing students and alumni, as 75% self-reported as being either good or very good students (see Figure 19). In total, 56% of respondents reported that they often or always received a grade of over 80% (see Figure 20). Although this “good student” bias was unexpected (a wider range of responses was expected), it is plausible that good students would be more likely than lower-performing students to respond to a survey enquiring about learning performance. Regardless, the data are valuable to this study as the purpose is to model behaviours that result in higher performance.
Data analysis resulted in two academic performance models being constructed, which were successfully modelled using the MSLQ items as independent variables. The next sections present each model and the behaviours uncovered for the entire sample. The behaviours are examined by running the same process on two subsets of the data: current students and alumni. These models are presented as sub-model A, which had a sample of 28 current students, and sub-model B, which had a sample of 39 alumni. Finally, each study behaviour’s scale is discussed in order to analyse the behaviours in terms of Bloom’s taxonomy of learning.
4.3 Model 1: Self-perceived Level of Academic Performance

The model and sub-models regarding students’ self-perceived performance were successfully constructed. Table 8 shows that the accuracy of the models was deemed acceptable, explaining a minimum 67% and a maximum 90.2% variance. The Durbin-Watson values were all within acceptable ranges of 1 and 3 (see section 4.2).

<table>
<thead>
<tr>
<th></th>
<th>ALM Accuracy</th>
<th>Durbin-Watson</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall model</td>
<td>67.7%</td>
<td>2.28</td>
<td>0.41</td>
</tr>
<tr>
<td>Current students sub-model</td>
<td>90.2%</td>
<td>2.02</td>
<td>0.83</td>
</tr>
<tr>
<td>Alumni sub-model</td>
<td>79.2%</td>
<td>2.40</td>
<td>0.51</td>
</tr>
</tbody>
</table>

The resulting items are discussed below.

4.3.1 Equation (1) Current students and alumni combined

\[ f(x) = (0.18)x_1 + (-0.21)x_2 + (-0.28)x_3 + 4.39 \] 

where:

- \( f(x) \) = How would you describe your academic performance as a student?
- \( x_1 \) = When I study for a class I pull together information from different sources, such as lectures, readings and course materials*
- \( x_2 \) = I often get so lazy or bored when I study for a class that I quit before I finish what I planned to do**
- \( x_3 \) = When a subject’s work is difficult, I either give up or only study the easy parts**

*Note: * \( p < .05 \), ** \( p < .01 \)

Instructors have long advocated seeking multiple sources of information when studying (Hynd 1999). The inclusion of study behaviour 1 \((x_1)\) in the overall model indicates that students are aware of the benefits of this approach when gathering information to improve their learning. Respondents who reported that they did this more often also reported that they believed themselves to be good students. This may suggest that higher-performing students have a stronger desire for knowledge acquisition, as they are routinely seeking information
from a wide variety of sources. However, it may also be that due to the wealth of information available on the Internet, students have become used to being able to seek multiple sources of non-study information. For example, many students may use multiple social networking sites like Facebook and Twitter to source information about their friends’ activities.

Conversely, there are times when students lose interest in the information they have at hand, as study behaviour 2 \((x_2)\) represents. This would be expected to have a fairly strong negative association with students’ self-perceptions as good academic performers. Students are now accustomed to interactive and engaging technology and are often distracted by it while studying (Rosen, Carrier & Cheever 2013). While this primarily explains the “bored” reaction to studying, the “lazy” response may result from the level of difficulty of the work. When students find a learning task too difficult, they often procrastinate (Pychyl et al. 2000), and are then more likely to terminate their study session before completion. This correlates very closely with study behaviour 3 \((x_3)\), whereby students who find studying too difficult only study what is easy. Study behaviour 3 was also found to have a negative impact on self-perceived academic performance. Interestingly, the fact that students still attempt to study (even just the easy parts) suggests that they are aware that studying is a worthwhile activity to improve grades; nevertheless, the difficulty or boredom they may experience when studying can inhibit their ability to study effectively. Next, the results are discussed for the two sub-models, one for current students and one for alumni.

### 4.3.2 Equation (1A) Current students

\[
f(x) = (-0.14)x_1 + (0.35)x_2 + (0.22)x_3 + (-0.48)x_4 + 3.88
\]

where:

\[f(x)\] = How would you describe your academic performance as a student?

\[x_1\] = If I get confused taking notes in class, I make sure I sort it out afterwards. *

\[x_2\] = I’m certain I can understand the most difficult material presented in the readings for a subject. ***

\[x_3\] = When I take tests I think of the consequences of failing. **

\[x_4\] = I often feel so lazy or bored when I study for a class that I quit before I finish what I planned to do. ***
4.3.3 Equation (1B) Alumni

\[ f(x) = (-0.25)x_1 + (-0.39)x_2 + (0.41)x_3 + 4.11 \]  

(1B)

where:

- \( f(x) \): How would you describe your academic performance as a student?
- \( x_1 \): During class time I often miss important points because I’m thinking of other things. *
- \( x_2 \): I rarely find time to review my notes or readings before an exam. **
- \( x_3 \): I try to apply ideas from course readings in other class activities such as lecture and discussion. **

Note: * \( p < .05 \), ** \( p < .01 \), *** \( p < .001 \)

It is interesting to note that upon first inspection of the two sub-models study behaviour 1 (\( x_1 \)) in both models is concerned with what is happening during a class, but where current students are identifying the problem with their study behaviour and are attempting to solve it, alumni are aware of the problem and understand why it happens. This difference in metacognitive awareness is consistent with the literature, which explains how metacognition develops over time (Kuhn 2000). Current students are focused on overcoming their immediate problem so as to continue towards graduation. Alumni tend to have a higher level of maturity and experience and so are able to identify the reason why they might miss important points in class; for example, because they are thinking of other things.

Further, current student study behaviour 1 had a negative correlation to self-perceived performance despite providing evidence of self-directed learning, which is a beneficial process (Garrison 1997). Clarifying confusion is a good learning strategy but it was found to have a negative relationship with self-perceived performance. One explanation for this might be that students are interpreting their confusion about a topic to mean that they are not good students, as they may incorrectly assume that good students immediately understand everything that is presented to them. Student study behaviour 3 (\( x_3 \)) could also be classified as a form of perceived academic inadequacy in that students are fearful of failing a test. However, this behaviour was found to be a positive indicator of perceived academic performance. Fear of failure can provide motivation for some types of students in various ways (Martin & Marsh 2003), and so it may be that students interpret their fear as justification of the importance of doing well on assessments. Generally, students’ goals are to
complete their degrees to transition into their career of choice, a hurdle that can create a level of anxiety (Cox 2009). This could explain student study behaviour 4 \((x_4)\), as completing what one plans to do is connects with coursework completion. Students completing tasks in preparation for tests may feel a level of anxiety not because they are ill-prepared but because they wish to validate their efforts by completing the test satisfactorily. In contrast, alumni study behaviour 2 \((x_2)\) and 3 \((x_3)\) demonstrate that alumni are more concerned with the bigger picture of studying. That is, not merely completing coursework and preparing for exams, but also applying ideas learned through study. This illustrates a more mature attitude towards study, whereby the purpose is not solely to pass assessments, but also to practically apply knowledge.

The analysis thus far has focused on individual study behaviours. It is also useful to consider the broader factors that these variables belong to in order to give further context to the findings of this research. Table 9 outlines the MSLQ subscales to which each model item belongs. The current student model has the closest relationship with the overall model as both feature elaboration and effort regulation as significant factors influencing self-perceived performance. The alumni model only shares one factor with the overall model, elaboration, which is used to describe strategies such as making summary notes or analogies to commit information to memory (Pintrich 1991). The elaboration scale measures the ability to understand information and process it for long-term recollection. Coupled with effort regulation, this suggests that both alumni and current students believe that working consistently and being able to organise and recall knowledge are essential skills for a high-achieving student.

Table 9: Model 1 factor summary

<table>
<thead>
<tr>
<th>Model Item</th>
<th>Overall</th>
<th>Students</th>
<th>Alumni</th>
</tr>
</thead>
<tbody>
<tr>
<td>(x_1)</td>
<td>Elaboration</td>
<td>Elaboration</td>
<td>Metacognitive self-regulation</td>
</tr>
<tr>
<td>(x_2)</td>
<td>Effort regulation</td>
<td>Self-efficacy</td>
<td>Time and study environment</td>
</tr>
<tr>
<td>(x_3)</td>
<td>Effort regulation</td>
<td>Test anxiety</td>
<td>Elaboration</td>
</tr>
<tr>
<td>(x_4)</td>
<td>N/A</td>
<td>Effort regulation</td>
<td>N/A</td>
</tr>
</tbody>
</table>
4.4 Model 2: Results-based Measure of Academic Performance

The results-based measurement of academic performance was also successfully modelled. Table 10 shows that ALM accuracy was acceptable, explaining 71.2% of the variance at the lowest and 86.7% at the highest. All three models (combined, students and alumni) fell within the acceptable range for the Durbin-Watson test.

Table 10: Model 2 reliability results

<table>
<thead>
<tr>
<th></th>
<th>ALM Accuracy</th>
<th>Durbin-Watson</th>
<th>$r^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall model</td>
<td>71.2%</td>
<td>2.22</td>
<td>0.49</td>
</tr>
<tr>
<td>Current students sub-model</td>
<td>86.7%</td>
<td>2.04</td>
<td>0.80</td>
</tr>
<tr>
<td>Alumni sub-model</td>
<td>74.1%</td>
<td>2.04</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Next, the significant items selected for each of the models are discussed.

4.4.1 Equation (2) Current students and alumni combined

$$f(x) = (0.24)x_1 + (0.30)x_2 + (-0.19)x_3 + (-0.19)x_4 + (0.14)x_5 + 2.16$$

where:

$f(x)$ = How often did you receive high grades (of over 80%) for assignments, exams or subjects overall?

$x_1$ = When I study for a class, I pull together information from different sources, such as lectures, readings and discussions**

$x_2$ = I usually study in a place where I can concentrate on my work**

$x_3$ = I find it hard to stick to a study schedule**

$x_4$ = It is my own fault if I don’t learn the material in a subject*

$x_5$ = When I study for a subject I write brief summaries of the main ideas from the readings and my class notes*

Note: * $p < .05$, ** $p < .01$

Seeking multiple sources of information—study behaviour 1 ($x_1$)—is common to both models 1 and 2, with each demonstrating that this behaviour has a positive impact on academic performance. Once again this is logical, as model 2 explains the factors that lead to
grades of over 80% and utilising only one source of information would severely limit students’ abilities to perform well in an assessment. Further, study behaviour 5 \((x_5)\) was found to have a strong positive relationship with performance for those students who summarise notes after class and from readings. This has previously been identified as a strategy adopted by high-performing students (Boyle & Forchelli 2014). Having the ability to distil the vast amount of information available should lead to improved grades because it allows the student to solidify their understanding of a topic. However, this may not lead to gains in performance for students who are unable to stick to a study schedule—study behaviour 3 \((x_3)\)—as not being able to do so was found to be negatively related to performance. This may be because it is related to study behaviour 2 \((x_2)\), which was found to have a strong positive impact on performance for students who were able to find places conducive to study. Previous work has identified that informal locations can be effective study spaces (Hunter & Cox 2014), provided that the surrounding stimuli are neither too distracting nor completely absent. Some students may not be able to identify when and where is appropriate for them to study, affecting their ability to follow a regular study schedule.

Study behaviour 4 \((x_4)\) was found to have a negative relationship to performance, which is inconsistent with existing research that suggests taking responsibility for learning has positive outcomes for learning performance (Nicholson et al. 2013). Previous research has shown that students typically attribute at least half of their learning to personal responsibility (Devlin 2002), and so it would be expected that high-performing students would take responsibility for their learning outcomes. However, if viewed from a different perspective, it may be that high-performing students who stick to a schedule and source appropriate material believe that they have exhausted every avenue to achieve their best possible mark. Hence, the keyword in this question is “fault”, in that good students do not believe that it is a fault in their effort or ability when they fall short of expectations, but that perhaps it is an area that requires further understanding.

4.4.2 Equation (2A) Current students

\[
f(x) = (0.21)x_1 + (0.16)x_2 + (0.37)x_3 + (-0.18)x_4 + 1.17
\]  

(2A)

where:

\(f(x) = \) How often did you receive high grades (of over 80%) for assignments, exams or subjects overall?
When studying for a subject, I often try to explain the material to a classmate or friend. **

When a theory, interpretation or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence. 

When I study, I set goals for myself in order to direct my activities in each study period. ***

During class time I often miss important points because I’m thinking of other things. **

### 4.4.3 Equation (2B) Alumni

\[ f(x) = (-0.33)x_1 + (0.54)x_2 + 2.68 \] (2B)

where:

\( \text{f}(x) = \) How often did you receive high grades (of over 80%) for assignments, exams or subjects overall?

\( x_1 = \) I often find myself questioning things I hear or read in a subject to decide if I find them convincing.

\( x_2 = \) I try to apply ideas from course readings in other class activities such as lecture and discussion.

**Note:** *p < .05, ** p < .01, *** p < .001

The most noticeable difference between the two models is in the number of significant items identified. The alumni model identified only half as many items as the current students model. Although this might indicate that the alumni model is too simple to explain all the important behaviours needed to achieve high grades (of over 80%), when considered in combination, the items in this model form a good description of what a high-achieving student does. That is, they are critical of information that is given to them—*alumni study behaviour 1* (\( x_1 \))—and when they are happy with the content, they confidently apply that knowledge in other relevant areas—*alumni study behaviour 2* (\( x_2 \)).

One aspect in which both models share an MSLQ scale was critical thinking, albeit with opposite effects. Current students reported that they try to decide if there is good supporting evidence for what is presented to them—*current student study behaviour 2* (\( x_2 \))—while
alumni often question what they read or hear—alumni study behaviour 1 ($x_1$). The difference here is that the alumni behaviour shows a higher level of intellectual confidence, whereas current students are somewhat hesitant to question information, and simply “try to decide if there is good supporting evidence”. Critical thinking for first-year university students, in particular, can be weaker as they have yet to gain significant expertise in this skill (Stupnisky et al. 2008). Further, because information is being disseminated at a university, to some extent current students automatically trust and do not question that information. This is interesting in terms of persuasive design, as a system that appears to have authority is more likely to persuade someone (Cialdini 2009).

An unusual finding from the alumni model is that alumni study behaviour 1 has a negative rather than positive influence on performance. This may be due to the wording of the question, which asks whether respondents “often” question things to “convince” themselves. Respondents may have answered this negatively as they may not “often” question things, but rather only when required. Once again, the university context may have meant the level of trust students had towards their university instructor resulted in students not often finding themselves needing to question what they hear, which is not to say that they never do so.

Providing some insight into current student priorities is current student behaviour 3 ($x_3$). The findings for this item indicate that students are goal-oriented while they study, which helps them to achieve an academic outcome of grades of over 80%. Goal setting has been identified as a key determinant of final grades (Zimmerman, Bandura & Martinez-Pons 1992). The lack of this or a similar behaviour in the alumni model may indicate that goal setting is only a main concern for students during study. Conversely, perhaps alumni do not remember using this as their main strategy when they reflect on their time as a student as a whole. Previous research has identified differences in goal setting for students who are of present and future time-orientation (Lasane & Jones 1999), and so it is possible that a similar pattern is occurring here between respondents of past and current time-orientation.

Table 11 shows that the list of variables for the two sub-models was very similar, with both featuring critical thinking and elaboration. Elaboration involves students using strategies that commit information to long-term memory by connecting new information with prior knowledge. The two factors would be expected to appear together for a high-achieving student. However, in the overall model, critical thinking was not listed at all. This is partly a result of the relatively small sample size available for creating the sub-models, but also
suggests that, when viewing study behaviour from a broad perspective, time and study environment and control of learning beliefs are more informative factors given the broader context. That is, finding the right environment and believing that one’s effort will result in a positive academic outcome are likely to lead to greater academic performance in general. In examining the critical factors at the individual (or student) level, however, it is the ability to think for oneself and integrate and connect new knowledge with what one has already acquired (the elaboration factor) that provides deeper insight. Further, metacognitive self-regulation would be expected to be an influential factor for current students as it involves planning, monitoring and regulating learning behaviour, as these are important skills for enhancing performance.

*Table 11: Summary of model 2 factors*

Model 2: How often did you receive high grades (of over 80%) for assignments, exams or subjects overall?

<table>
<thead>
<tr>
<th>Model Item</th>
<th>Overall</th>
<th>Factors</th>
<th>Students</th>
<th>Alumni</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x_1$</td>
<td>Elaboration</td>
<td>Elaboration</td>
<td>Critical thinking</td>
<td>Elaboration</td>
</tr>
<tr>
<td>$x_2$</td>
<td>Time and study environment</td>
<td>Critical thinking</td>
<td>Elaboration</td>
<td></td>
</tr>
<tr>
<td>$x_3$</td>
<td>Time and study environment</td>
<td>Metacognitive self-regulation</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>$x_4$</td>
<td>Control of learning beliefs</td>
<td>Metacognitive self-regulation</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>$x_5$</td>
<td>Elaboration</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

**4.5 Findings**

Analysis of the overall models for academic performance revealed that there is very little commonality between each of their learning behaviour predictors. At the overall level, there was only one instance of two models sharing the same behaviour: “When I study for a class, I pull together information from different sources, such as lectures, readings and discussions”. In the sub-models, only one behaviour was found in multiple models: “During class time I often miss important points because I’m thinking of other things”. This reinforces the idea that learning is a complex process, and no single behaviour leads to strong academic performance.
When the individual behaviours were analysed from the point of view of their broader factor scales, there was some overlap with the existing MSLQ models described earlier. In comparison to Hilpert et al. (2013) model, there was significant individual behaviours that belonged to each of the top-level scales, not simply expectancy, value and resource management. There was also a correlation between the factors identified by this study and the factors featured in Sungur (2007) model. Factors such as task value, control of learning beliefs, metacognitive self-regulation, effort regulation and self-efficacy were identified as significant in both studies. The Hilpert et al. (2013) model also shared the same subscale factors, leading to the conclusion that these are likely to be important factors to consider when designing learning objectives and educational systems. This is given further weight when one considers that this research was designed to identify individual behaviour items first and then overall factors, whereas the related work aimed to model the scale using all of the available MSLQ items, and yet each study found similar significant factors. This demonstrates the versatility of the MSLQ and its ability to reliably measure learning strategies for multiple purposes.

At the variable level of the models, some differences were identified between current students and alumni in the general types of behaviours and strategies found to be significant. Current students were typically engaged in behaviours and strategies that had more of an immediate urgency in terms of their learning, rather than the longer-term view held by alumni. The models also featured several behaviours that reflected feeling “lazy or bored” or “distracted”. This suggests that learning environments should be as engaging as possible, yet not to the point that they are distracting for students. For example, mobile technology can positively augment the learning environment, but can also distract students from their classroom activities (McCoy 2013).

It was also evident from the results that the learning behaviours of both current students and alumni were at some of the higher levels of Bloom’s taxonomy. For instance, metacognitive self-regulation and elaboration featured in each model, at both the overall level and the sub-model level. This was in addition to what could be considered lower level of Bloom’s taxonomy of learning such as time and study environment and effort regulation. The combination of lower- and higher-level learning behaviour factors in the models supports the original interpretation of the taxonomy. One must graduate from the lower levels to the higher levels and should not attempt higher-level thinking without first mastering the basics.
(Bloom 1956). This could be a result of modern university degrees incorporating the taxonomy into their course design and strengthens the argument that this is an ideal approach to producing high-performing academic students.

The behaviours and strategies present in the models and the higher levels of Bloom’s taxonomy reached by alumni also demonstrate how good students naturally develop their study behaviours and strategies. This is likely a result of the education systems in which the students have been immersed, from early years through to tertiary learning. There is little evidence of a widely used and purposefully designed persuasive learning system, so these behaviours must be a product of the natural learning environment. The goal of any future persuasive system should be to enhance the transition from current student to alumni, and encourage higher levels of Bloom’s taxonomy in underperforming students. In relation to the PSD framework, this progression will help better develop the strategy of persuasion as it provides the designer with greater insights into student behaviour.

4.6 Summary

In this chapter, two models were created that covered different dimensions of performance—self-perception and results achieved. The data were modelled based on current students and alumni and identified a general trend towards behaviours and factors that provide immediate benefits for current students, and higher-order thinking behaviours and factors for alumni. The models form the basis from which persuasive systems can be designed to improve learning outcomes since they provide a richer picture of how student learning behaviours naturally develop. The subsequent chapters use the results of this phase of the research to inform the design choices of the persuasive elements in the DLE selected.
Chapter 5: Selection of a Learning System Platform

5.1 Overview

The first phase of this research identified two models of student study behaviour with the purpose of understanding current issues with study behaviour. The individual behaviours identified in the models can be used to underpin the persuasive design of a learning system to ensure that any barriers inhibiting students from achieving the target behaviour of engaging with coursework are minimised. To conduct this process, a base system must first be identified, which is the purpose of this chapter. Two systems, Blackboard and TTM, were identified as feasible candidates from which to measure the persuasiveness of a learning system. Both were evaluated by an expert focus group against the postulates of persuasive design and the PSD model system qualities. As a result, a single system, TTM, was selected using an expert panel focus group, which determined it to have the greater potential for persuasion to occur, and therefore to be more suitable to measure persuasiveness in a real-world setting.

5.2 Digital Learning Environments

The systems analysed for persuasion in this research, Blackboard and TTM, are DLE. A DLE is the main piece of technology students interact with while studying at university and plays a crucial role in creating engagement between students and course materials. For some time, these systems have taken the form of learning management systems, with Blackboard being a popular choice for many universities. The issue with a learning management system being used as a DLE is that it is geared more towards supporting students and instructors in the administrative aspects of learning rather than towards the actual learning that takes place (Brown, Dehoney & Millichap 2015). Further, traditional learning management systems do not provide high levels of interactivity between the system and students (QUT 2014). This has resulted the literature calling for next-generation DLE—digital ecosystems involving instructors, students, tools and content with the intent to directly support learning (Brown, Dehoney & Millichap 2015). A prototype system, TTM, addresses these issues by providing a DLE that is student-centred and involves instructors in the learning process. TTM is designed based on established pedagogies including mastery learning and Keller’s personalised system of instruction (Cheong & Cheong 2016,) which is designed to enhance
the interactivity lacking in traditional learning management systems. TTM is not designed to replace Blackboard but can be used in conjunction.

5.2.1 Blackboard Learn

Blackboard is commonly used by universities because it provides many useful tools to allow students to manage their studies. Typically, Blackboard is used as a document repository where lecture slides and recordings, tutorial tasks and course notes are uploaded for students to access at any time. Assessments are also distributed through Blackboard and the system allows students to upload their work for those assessments. This creates a central repository for instructors to retrieve assignments. From there, instructors can mark the work and enter a result in students’ grade books. Blackboard also provides functionalities to create multiple-choice tests for students. These can be used for assessment or as exercises for students to improve their knowledge. There is a social component to Blackboard through the use of a discussion board that allows for contributions from both instructors and students. Instructors can also communicate with students through the announcements section, which can also be emailed to students.

Blackboard is feature-rich, but there is no prescribed approach for how these features are to be used. Many features are optional and the decision on whether or not to use them and how is left to instructors. This could have an adverse effect on persuasion since most cases rely on students having to decide how to use the system in terms of what they need to do and in what order.

5.2.2 Task-Test-Monitor

TTM is the next-generation DLE evaluated in this study. It differs to Blackboard in how it operates and its initial feature set is far more limited. This is a result of Blackboard being designed to support the management of learning in a more holistic sense, whereas TTM focuses on supporting students in selected phases of their actual learning process. Although more limited, TTM’s features have been designed to work together to form a single cohesive structure to support learning. In essence, Blackboard provides breadth of support across multiple features, whereas TTM provides depth in limited features.

TTM encourages instructors to break down the course content for each week into small, bite-sized tasks and tests. The tasks require students to carry out some form of work, such as
completing a small programming exercise or watching a video to understand a concept. After completing the tasks, students can self-assess their understanding by completing a multiple-choice test. The tests can be taken as many times as students desire and for each answer, both correct and incorrect, students are given feedback as to why that is so (see Figure 21). Students can navigate through their history of attempts and monitor their own performance using the recent history chart found at the top of the main page where the tasks and tests are accessed (see Figure 22). When students complete a test with a score of 80% or higher, the system recognises it as completed. Students can monitor their overall progress in a course through the progress bars featured in the system.

![TTM test feedback](image)

*Figure 21: TTM test feedback*
5.3 Persuasion Context

The environment in which the systems are implemented should be given careful consideration so that observations and evaluation can be grounded in the reality that students experience. In a sense, system designers should take a user-centred approach to persuasive evaluation. There are three components to the persuasion context as prescribed by Oinas-Kukkonen and Harjumaa (2009): intent, event and strategy. A combination of all three forms a reliable base when assessing the results of the persuasive feature evaluation. The following sub-sections explain each sub-context and give examples of how they relate to Blackboard and TTM. A high-level summary is presented in Table 12.
Table 12: Persuasion context for learning

<table>
<thead>
<tr>
<th>Persuasion Context</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intent</strong></td>
</tr>
<tr>
<td>Persuader</td>
</tr>
<tr>
<td>Intended Outcome/Change</td>
</tr>
<tr>
<td>Designer Bias</td>
</tr>
<tr>
<td><strong>Event</strong></td>
</tr>
<tr>
<td>Use Context</td>
</tr>
<tr>
<td>User Context</td>
</tr>
<tr>
<td>Technology Context</td>
</tr>
<tr>
<td><strong>Strategy</strong></td>
</tr>
<tr>
<td>Message</td>
</tr>
<tr>
<td>Route</td>
</tr>
</tbody>
</table>

5.3.1 Intent

Intent, in the persuasion context, defines who the persuader is and who will be the recipient of influence. In the context of a DLE, the persuader is the instructor running the class and the users being persuaded are the students. This relationship has arguably always been present in the education domain because it is part of the instructor’s role to motivate students to learn, and students are likely to have the expectation that attending university involves being taught how to improve and change one’s thought process. As both Blackboard and TTM are extensions of the traditional learning environment, it can be presumed that students will also transfer this paradigm of an instructor as persuader to these systems. Both systems support this purpose as they are fully in the control of the instructor. Neither system would have difficulties implying through their design and operation that the instructor of the class is the person who intends on influencing the students’ behaviour. Designer bias is also addressed in a similar manner, as it can be argued that students generally accept that a DLE would be designed with the implication that receiving higher scores in tests is the desirable behaviour.
5.3.2 Event

Effective persuasive systems are designed to be compatible with who the user is and how they want to use the system, which in most cases is to achieve a certain goal. Collectively, the user, the use of the system and the goals of the user represent the event that is taking place at a certain time. Designing DLE to meet these criteria is becoming increasingly difficult as universities are facing larger and more diverse cohorts of students. However, one common goal that all students share is to complete their degrees. DLE should ensure that their purpose is to support students in progressing through the required materials while developing and refining their knowledge and skills. Both Blackboard and TTM allow students to track their progress towards this broader goal; however, TTM is more obvious in this because it has a performance-tracking section, whereas Blackboard relies on the Grade Center, where assessment grades are displayed in order to measure progression. Both systems are appropriately integrated into the event of university learning.

5.3.3 Strategy

The third sub-context, strategy, is the persuasive message being directed at the user by the persuader, and the route that the message takes. The key message that DLE typically convey to students is that completing coursework to a high standard is valuable to them, as doing so will lead to completing the degree. The route that this message can take may be indirect, as generally students would be aware that working hard leads to better academic grades and degree completion. Subtle cues in the interface, such as visually representing progress, may be a suitable method to convey this message. Both Blackboard and TTM are capable of effectively communicating a persuasive message through their design and interface. Blackboard may have an advantage in this regard, given its flexible configuration nature. TTM can make use of visualisation and purposeful layout to convey a message.

In summary, both systems have the potential to be persuasive if they are suitably implemented into the learning environment. To establish whether one system is more capable than the other, the next section conducts further analysis at lower levels of implementation.

5.4 Analysis of Digital Learning Environments

To ensure that each system was evaluated appropriately using the PSD model, an expert analysis style focus group was formed. As discussed in section 3.4.1, the group comprised of
three research team members (the author of this thesis and his two supervisors), a research student and an undergraduate intern who was undertaking co-operative employment at the time of the study. The group provided different perspectives and experiences of using the systems. Two members of the expert panel are academics who have used both Blackboard and TTM in the delivery of their courses. One member has nine years and the other has 15 years of teaching experience, particularly using Blackboard. The research student has experienced both systems as a student.

Each item in the PSD was discussed in relation to both Blackboard and TTM until a consensus was reached on whether each system features that aspect of persuasion and in what way it implements it in line with the research of Langrial et al. (2012) and Lehto and Oinas-Kukkonen (2010). The group also took into account the overall system design when assessing the features. The analysis was recorded by the author of this research in a table outlining the persuasive element and the feature or design trait that satisfies that criteria. The following sections present the observations made by the team when discussing Blackboard and TTM in relation to the four main categories of system characteristic design.

5.4.1 Primary task support

The primary task support that Blackboard offers is rehearsal, reduction and self-monitoring, albeit not very strongly. Using lecture materials and course notes uploaded by instructors in combination with multiple-choice tests allows students to rehearse their target behaviour, which is to learn and acquire new skills and knowledge. This is the most prominent form of primary task support that Blackboard offers. When used as a document repository, it provides a level of reduction by making content easier to find for students. Displaying grades to students can be classified as self-monitoring; however, Blackboard generally only provides three to four data points of performance history for a class and is too high level to be effective. Multiple-choice tests can help provide fine-grained data on how a student is progressing, but instructors must ensure they enable multiple attempts at completing tests otherwise the persuasiveness of the rehearsal dimension is reduced. There is some level of personalisation in that each student logs in using their university account, and content is grouped by courses that they are enrolled in. Blackboard does not offer features that can be directly associated with tunnelling, simulation and tailoring as per the PSD framework definitions.
TTM is designed to help students complete coursework, which provides the foundation from which assessments can be completed. For this reason, TTM has a very strong implementation of primary task support, as it is clearly set up for this purpose. The four aspects implemented strongly are self-monitoring, rehearsal, reduction and tunnelling. The recent history and overall performance charts are visual representations of students’ learning progress that are easy to understand. This provides opportunities for self-monitoring that would be otherwise unavailable to students, or would require manual monitoring. The automated nature of the progression data provides support for reduction. The ability to undertake the tests an unlimited number of times provides strong rehearsal qualities in the system. This flexibility could mean that students undertake the same tests multiple times at different points in the semester. For instance, at the time of first completing the task, then again prior to an assignment being due and, finally, before an examination. Although there is great flexibility in how to use the system, it can be argued that there is also some minor tunnelling. Students are free to complete tasks and tests in any order they wish, but the system presents the course material in a suggestive manner since it is organised by week, then numbered in order. There is some level of personalisation, with the student being greeted by name on the welcome screen and the chart data representing their own performance; however, this is not very strong. TTM does not provide simulation or tailoring.

5.4.2 Credibility support

Credibility support is quite strong in Blackboard. Students log in with their university accounts, and this provides trustworthiness. To a lesser extent, third-party endorsement may be present as students are likely to have enrolled at the university because of its established reputation. Making Blackboard the main system to access course material indicates to students that Blackboard is credible. The look and feel is generally clear and logical for a learning management system and this provides surface credibility, although this is dictated by how the instructor sets up the structure of the content. Instructors typically enter their contact details in the system, which also provides real-world feel and authority. Content is determined by what is relevant for that particular course, but instructors are likely to create academic content that is fully referenced, meaning verifiability and expertise would be demonstrated. It is clear that Blackboard is a credible system based on these PSD items.

TTM also has strong credibility support. As the system has content developed by the students’ instructors, this provides trustworthiness and expertise. The assumption is that
students have enrolled in the university because they trust that the staff and learning materials are reputable; hence, a system which features content created by those same instructors would logically also carry the same trust. Following from this, the instructors also provide authority as it is clear they are the people behind the system, which is an important distinction to make in a persuasive system. This also creates a real-world feel. The instructors can actively encourage the use of TTM, enhancing the persuasiveness of the system. Although the content in the tasks and tests for each course may vary, tasks, tests or lecture supporting material have links to external sources, which provide verifiability. The system itself is designed using the Twitter Bootstrap CSS\textsuperscript{13} and Angular JS\textsuperscript{14} as a framework (Cheong & Cheong 2016), and so has a professional and well-designed look and feel. This provides surface credibility for the system.

5.4.3 Dialogue and social support

Blackboard does not feature many components that could be classified as dialogue support. It can be argued that it does feature liking since the look and feel of Blackboard is generally pleasing to students. The system offers the ability to send reminders, but this is predicated on the instructor manually using the announcement features to remind students to complete coursework. Although possible, this would require considerable effort from the instructor. The system does not offer specific praise or rewards for using the system, relying solely on feedback from assessments to provide these. Similarity, suggestion and social role are missing from Blackboard, and social support is lacking. A prominent feature is the discussion board that is available to students; however, it is difficult to align this feature with the social support items from the PSD. One way in which it aligns is that students are able to coordinate group assignments or seek help from their peers using the discussion board, providing cooperation in the system. No other features were identified that could satisfy the remaining items in the social support category of the PSD.

Like Blackboard, TTM is lacking in dialogue support and social support. Currently, TTM does not contain any features or design patterns that can arguably fall under either of those two categories. This can be attributed to TTM being designed with the very specific purpose

\textsuperscript{13} http://www.getbootstrap.com
\textsuperscript{14} http://www.angularjs.org
of providing a means of self-monitoring the learning process through the completion of coursework.

5.5 Discussion of Digital Learning Environments

At a high level, both systems scored fairly evenly overall in terms of the number of persuasive elements they contain. Primary task support is featured to a similar extent, with the difference being that Blackboard provides personalisation whereas TTM incorporates tunnelling. Dialogue support is lacking in both systems, with both only containing liking although Blackboard has the added support of reminders. Both systems were found to be identical in their credibility support, although they achieve it in different ways. Finally, both systems lack social support, excluding some very minor support in Blackboard through the online discussion forum. It can be argued that some PSD construct items could have been counted if an instructor manually provides support for some items within the system, such as providing praise in comments or feedback. This was not included for the reason that the system should provide the feature at least semi-automatically with little to no effort required from instructors. For example, authority was counted in the system if instructors recommended the system’s use or performed semi-regular check-ups with students on their progress. These actions do not require the same level of effort as manually writing individualised praise.

Table 13 summarises how the expert analysis of the systems were evaluated

<table>
<thead>
<tr>
<th></th>
<th>Blackboard</th>
<th>TTM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Task Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-monitoring</td>
<td>Yes (grades)</td>
<td>Yes (test feedback, recent history chart)</td>
</tr>
<tr>
<td>Reduction</td>
<td>Yes (content repository)</td>
<td>Yes (automated progress tracking)</td>
</tr>
<tr>
<td>Personalisation</td>
<td>Yes (enrolled courses)</td>
<td>No</td>
</tr>
<tr>
<td>Rehearsal</td>
<td>Yes (course materials and multiple-choice tests)</td>
<td>Yes (unlimited multiple-choice test attempts)</td>
</tr>
<tr>
<td>Tunnelling</td>
<td>No</td>
<td>Yes (site structure and layout)</td>
</tr>
<tr>
<td>Simulation</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tailoring</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 13: Summary of persuasive elements present in Blackboard and TTM
<table>
<thead>
<tr>
<th></th>
<th>Blackboard</th>
<th>TTM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dialogue Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reminders</td>
<td>Yes (emails)</td>
<td>No</td>
</tr>
<tr>
<td>Praise</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Suggestion</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Rewards</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Similarity</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Social role</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Liking</td>
<td>Yes (look and feel)</td>
<td>Yes (look and feel)</td>
</tr>
<tr>
<td><strong>Credibility Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trustworthiness</td>
<td>Yes (university account login)</td>
<td>Yes (university account login)</td>
</tr>
<tr>
<td>Real-world feel</td>
<td>Yes (instructor details)</td>
<td>Yes (instructors promote system)</td>
</tr>
<tr>
<td>Expertise</td>
<td>Yes (academic content)</td>
<td>Yes (academic content)</td>
</tr>
<tr>
<td>Verifiability</td>
<td>Yes (academic content)</td>
<td>Yes (academic content)</td>
</tr>
<tr>
<td>Authority</td>
<td>Yes (implied through instructor)</td>
<td>Yes (implied through instructor)</td>
</tr>
<tr>
<td>Surface credibility</td>
<td>Yes (look and feel)</td>
<td>Yes (look and feel)</td>
</tr>
<tr>
<td>3rd party endorsements</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Social Support</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social competition</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Yes (discussion forum)</td>
<td>No</td>
</tr>
<tr>
<td>Social facilitation</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Normative influence</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Competition</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Social learning</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Recognition</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

5.5.1 System characteristics

Although both systems have similar levels of inherent persuasion, it is important to consider the high-level purpose or intent of the system, which is to support and encourage student learning. With that in mind, the differences in how each system is persuasive are now discussed, starting with primary task support. In this regard, TTM has the potential to be persuasive in supporting students’ primary task of completing coursework. This is due to the more focused purpose behind the design of TTM. While Blackboard features many individual persuasive elements, it does not appear that any of those features were necessarily designed to work in unison to persuade the user to perform a certain action. Conversely, TTM is
deliberately designed to tunnel students through a certain path in the system, albeit not strictly, allowing flexibility for progression. For Blackboard to be persuasive through the cohesion of multiple features, effort is required on the part of the instructor to deliberately set up the system for persuasion to occur. While this makes it theoretically possible for Blackboard to provide similar levels of persuasion to TTM, the instructor is not given any direction on how to do this. Previous studies have found that when given customisable options in a system, most people will not take advantage of the function as the effort required takes away time from completing actual work (Mackay 1991). This means instructors may not appropriately tailor Blackboard to their needs. In one study, instructors only made use of the more basic features of Blackboard (Carvalho, Areal & Silva 2011). Without customising Blackboard’s features, the likelihood that effective persuasion will occur is reduced. Further, it is very unlikely that an individual feature in isolation will cause meaningful changes in a student’s behaviour or attitude. TTM, however, is purposefully designed to support student learning. It was developed by course instructors and the features are designed to act as one cohesive system. This is a crucial aspect to consider as simply identifying many individual persuasive features does not necessarily result in an effective persuasive system, but careful design of the user experience of the features would help improve persuasiveness (Räisänen, Lehto & Oinas-Kukkonen 2010).

Credibility support is strongly implemented in both systems. This is to be expected as the content as well as the instructors are the same for both. Sharing the same content, it is expected that verifiability, expertise and trustworthiness would be present. In both systems, the instructors play the role of authority figures, and it is clear to students in both systems that the instructors are the people behind the system and the purpose is to help students with their learning. Both systems require students to log in using their university accounts. The standard login interface is likely to instil a sense of trust in students that the systems are legitimate.

Dialogue support and social support are equally lacking in both systems. This may have a larger negative impact on persuasion for Blackboard rather than TTM because TTM has a stronger sense of primary task support. Although dialogue and social support are important factors for persuasion in general, they are not crucial for students to achieve their goal, which is to complete a course to the best of their ability. Although TTM is just as lacking in these areas as Blackboard, its stronger primary task support may be viewed as more valuable to students and therefore may result in more effective persuasion. That is not to suggest that
dialogue and social support should not be incorporated into TTM at a later stage. For instance, limited dialogue support was shown to contribute to lower likelihood of persuasion in weight loss apps (Lehto & Oinas-Kukkonen 2010). This aspect needs to be improved in both systems. Reminders could be implemented through a mobile app sending push notifications. The feedback provided in the systems allows for an opportunity to enable social interaction through reflection-on-action, which has been identified as one of several approaches to implementing this system characteristic (Ploderer et al. 2014).

5.5.2 Postulates of persuasive system design

This section considers how the two systems align with the postulates of persuasive systems (Oinas-Kukkonen & Harjumaa 2008). The first postulate, that all systems are capable of influencing behaviour, is apparent by the large number of features that align with each scale of the persuasive systems model in both systems, despite neither being explicitly designed to be a persuasive system. Both systems provide means for direct routes of persuasion, as instructors can tailor messages and feedback to encourage students to work harder on their coursework. However, TTM offers more potential for indirect persuasion through its implementation of tunnelling and user interface layout. The repetitive cycle of completing tasks, tests and then receiving feedback indirectly persuades students to adopt that approach to their study. Blackboard does not provide this kind of experience. Further, the tunnelling in TTM enhances the ability for the system to provide incremental persuasion that occurs over time, aligning well with the fourth postulate of persuasion. Both systems meet the fifth postulate of being open, as it is clear that the instructors endorse the system and have created the content within it, which is expected to be truthful and accurate. Both systems are unobtrusive; however, this is due to their lack of dialogue support, as each system requires the user to initiate its use. Finally, both systems are generally useful and easy to use, supporting the seventh postulate. When considering the target behaviour of encouraging students to complete more coursework, TTM is arguably more useful as it provides a streamlined and easy-to-follow interface for students to complete work.

5.6 Selecting a System

Both Blackboard and TTM perform the function of supporting student learning, albeit for different purposes. TTM features a stronger focus on primary task support for the purpose of encouraging progression through coursework. It also has greater alignment with the key
postulates of PSD. Blackboard’s strength is that it provides students and instructors a platform to manage their learning. Blackboard features better functionality for general learning administration, such as grade tracking, assessment submission and acting as a study repository. However, its usefulness in persuading behaviour may be restricted by trying to provide too many functions to students. This is a strength as a learning management system, and a weakness as a DLE. Hence, it appears that, overall, TTM is more likely to be successful in being a persuasive DLE. Being built on modern open web technologies (Bootstrap, AngularJS and NodeJS), means TTM is more easily expandable compared with Blackboard’s closed system.

As a result, TTM was selected as the base system on which further persuasive system qualities were built. TTM does not feature a mobile app, and so one was developed as part of the implementation stage in this research. As mentioned, a mobile app can enable push notification functionality that can be used to implement the reminders construct in a system, as well as provide opportunities to trigger behaviour. Adding reminders to TTM’s strong self-monitoring and tunnelling will result in a stronger implementation of persuasion, as these three system qualities have previously been identified as being particular beneficial (Karppinen et al. 2016). More details of the implementation are described in the next chapter.

5.7 Summary

This chapter outlined the results of an expert analysis focus group that identified a feasible baseline system to which persuasive features could be added and then used in a classroom setting for evaluation purposes. Two existing DLE, Blackboard and TTM, were compared to evaluate their inherent persuasion. Both systems contained similar levels of inherent persuasion, particularly for the constructs of primary task support and credibility support. Both systems were lacking in dialogue support and social support. Despite the similarities in number of persuasive features, TTM was selected as the preferred system to develop further persuasive features and used as the system to measure the potential of a learning system to influence study behaviour. The next chapter designs for persuasion by aligning the previously identified study behaviours with new and existing system qualities in TTM.
Chapter 6: Designing and Enhancing Persuasiveness in Task-Test-Monitor

6.1 Overview

This chapter presents the final step of phase 2, which enhances the TTM system selected by the expert analysis focus group with further persuasive design elements. The purpose is to have a persuasive system that can be used for data collection during phase 3. To provide a comprehensive overview of the persuasive design in TTM, both the inherent persuasive features that already exist in the application, as well as new persuasive features added as part of this research, are described. Persuasive features should underpin desirable behaviours as ultimately this is the goal of such a system: to influence behaviour. Without this, any perceived persuasiveness would be minimal if non-existent. Persuasive design elements are grouped into categories and are presented with the previously identified study behaviours (see Chapter 4) they intend to influence. Features were built over several iterations across multiple semesters using a rapid development approach. Feedback from students and instructors was used to continually improve the system. There are two components to the TTM system: the original web-based platform and a mobile app called Study Helper that was purposefully constructed for this thesis. The web-based features identified as already existing in the persuasive design include bite-sized tasks and tests, an automatic to-do list, visualisation and the use of authority to instil credibility. A new addition to the web-based system is study hints and tips based on the behaviours found in phase 1. The mobile component, Study Helper, is entirely new, and implements all the existing features of the web platform excluding the bite-sized tasks and tests. A unique persuasive feature in Study Helper is the push notification system intended to improve dialogue support.

6.2 Task-Test-Monitor System

This section presents a high-level understanding of how the TTM system is designed and how it is intended to operate in classes. TTM has a simple interface that is designed to allow students to find what they require quickly. At a high level, students have access to three areas: course content, performance tracking and analytics. The course content area is where students spend most of their time (see Figure 23) since it is where the weeks of the semester are listed and tasks and tests are accessed. Tasks are broken down into bite-sized pieces (see
section 6.3.1) to make them easier to complete. On the right-hand side of the screen there are study tips and the automated to-do list (see sections 6.3.2 and 6.3.4). The performance area of TTM tells students how they are progressing through their course (see section 6.3.3) by allowing them to see which tasks and tests have been completed, the average score for tests, as well as overall percentage progression. All of these individual components combine to create the persuasive effect that is evaluated in phase 3. The following sub-sections detail the persuasive design choices for each feature and how they align with the existing behaviours identified in phase 1.

![TTM Course Materials - E-Business: Week 1](image)

**Figure 23: Overview of the TTM structure**

To understand the overall operation of how TTM functions, there are four key components to examine: a web-based platform, a mobile app, students and instructors. Figure 24 provides an overview of the components and their interactions. The most basic interaction is between the student and the web-based platform. The student completes tasks and tests, and the system
provides feedback on the test results in response. This is the core way the system supports students' primary task. To provide a more direct route of communication, and to improve dialogue support through reminders, the mobile app is used to send push notification messages directly to the student. These messages are designed to elicit conscious thought towards completing tasks at times when the student is not in class and possibly engaged in other activities. The student can use the app to then check their progress in the system, which helps them maintain a study schedule and improve their skills. The relationship between the student, the web-based system and Study Helper can function in a cyclical manner for as long as the student is being triggered. The instructor plays an important role in this process of encouraging active use by leveraging the persuasiveness of authority. The instructor performs semi-regular check-ups, which involve having the student demonstrate their progress in the system. This emphasises the importance of completing the tutorial work in class. If the student is performing well, it is an opportunity for the instructor to praise the student, utilising dialogue support. If students fall behind, it provides a means of early intervention, allowing the instructor to help correct their behaviour prior to undertaking assessment.

The next sections explore and discuss the lower-level operation of the persuasive design choices, the alignment of the system qualities and the previously identified study behaviours.

6.3 Web-based Persuasive Design

The following sub-sections list the related positive study behaviours identified in Chapter 4: that are then implemented as new or identified as existing system qualities. New added features are also described. Overall, TTM has several persuasive features that encourage students to complete weekly tasks and tests. These features include tasks and tests that are
bite-sized, an automated to-do list, visual representation of key data, as well as study hints and tips. Unlike these features, how the system is used in class by students and promoted by instructors is intangible yet persuasive, and so this is also described.

6.3.1 Bite-sized tasks and tests

Some behaviours identified during the behavioural analysis indicated that students struggle with completing coursework. The reasons why include feeling unmotivated, lacking persistence when the material is difficult to understand, fearing the results of tests and struggling to record and use notes. One explanation for this is that course material can be quite long since it is designed to be initiated in-class and then continued at home. A micro-learning approach can address these common student issues by breaking down content into smaller manageable pieces. This approach could target the following five previously identified study behaviours and strategies:

1. I often get so lazy or bored when I study for a class that I quit before I finish what I planned to do (negative impact on academic performance).

2. When a subject’s work is difficult, I either give up or only study the easy parts (negative impact on academic performance).

3. I’m certain I can understand the most difficult material presented in the readings for a subject.

4. When I take tests I think of the consequences of failing.

5. I rarely find time to review my notes or readings before an exam.

In line with the micro-learning pedagogy, TTM breaks down traditionally lengthy tutorial tasks into smaller 15 to 20 minute “bite-sized” components. This technique heavily leverages the concept of reduction from the PSD model.

A key problem to overcome when attempting to encourage students to work is procrastination. Students tend to put off completing work if the task appears too difficult, particularly if the content is not interesting to them (Blunt & Pychyl 2000; Harrington 2005; Milgram, Sroloff & Rosenbaum 1988). Therefore, by dividing tutorial tasks into smaller pieces, students would be asked to complete a single small task, which would appear far more
manageable and improve the likeliness of completion. This design pattern addresses the issue in behaviour 2 (listed above), which indicates that when work is difficult, students lose motivation to complete it, which has a negative impact on self-perceived academic performance.

In TTM, each task outlines any prerequisites before commencing. After the task is completed, students are presented with the next steps (contained in the task instructions), which provides a basic level of tunnelling. Tasks are also labelled by week and then task number, indicating order. Tunnelling is particularly useful here to help reduce procrastination by providing direction, indirectly reducing the effort required of students to deduce what they should be doing next. Most tasks have an accompanying test consisting of five multiple-choice questions that provide immediate feedback to students about their selected answers, supporting them in understanding the material (addressing behaviour 3) without the consequences of failing (addressing behaviour 4). Students can attempt the tests an unlimited amount of times, enabling rehearsal, which can be valuable in preparation for assessments and examinations (encouraging behaviour 5). The tasks and tests are organised by week and listed in numerical order, reinforcing tunnelling albeit at a higher level than the next steps mentioned previously. The combination of tunnelling and rehearsal could address the issue of feeling lazy or bored. It could minimise the chances of students getting distracted from what they need to do in TTM by making it easy to follow and understand. Figure 25 shows where students access materials in TTM; tunnelling is on the left-hand side of the figure.
6.3.2 Automatic to-do list

While breaking down tutorial tasks into smaller pieces assists with reducing the perceived effort required in completing course content, it does not guarantee students will continue to work through content. That is, the bite-sized pieces make it easier to begin an interaction, but do not solve the longer-term issues of completing all the work. The problem of long-term engagement is evident in this behaviour identified in phase 1: “I find it hard to stick to a study schedule (negative impact on academic performance)”.

An undesirable consequence of breaking down weekly tutorial tasks into bite-sized pieces is that it results in a higher number of tasks and tests that students need to complete. Students may have difficulty keeping track of what they have and have not done and, without support, this could reintroduce procrastination. To alleviate this problem, TTM has a built in to-do list that automatically tracks what has been completed, including both tasks and tests (see Figure 26). When manual management of a to-do list is required, it can be neglected after a period of time as people often have difficulty managing it (Bellotti et al. 2004), which may be why students “find it hard to stick to a study schedule”. To make sticking to a schedule easier, the TTM automated to-do list updates as soon as a student submits a task or test in the system.
To-do items are timed to only appear in their relevant week, which avoids overwhelming students by listing every task and test to complete for the whole semester. For example, at the commencement of week 3, only the tasks for week 3 (not week 4 or other weeks) appear as “tasks to do”. This helps limit the list to be completed, providing sharper focus and potentially avoiding overwhelming students who might then procrastinate. The list is displayed on the right-hand side of the page and is visible in most locations in TTM. Placing the list in this location acts as visual reminder to students of what they need to do, and reduces the effort required in managing it to zero. The tasks and tests are labelled with a week and sequence number, so students can quickly place where they are in the course by checking the week number the task or test belongs to against the current week of the semester. The overall effect of the to-do list is that students are more likely to seek out the tasks and tests they have yet to complete and then do so. An example of the to-do list is shown in Figure 26.

6.3.3 Visualisation

TTM captures a vast amount of data related to task and test completion, particularly as tests can be completed an unlimited amount of times by students. To quickly convey important information to students from these data, TTM relies heavily on visual representation. A
behaviour identified in phase 1 that can be supported by visualisation is: “When I study, I set goals for myself in order to direct my activities in each study period”.

The most prominent implementations of visualisation in TTM that can be used for goal setting are the use of bars measuring progression of course completion (see Figure 27), the task and test performance charts (see Figure 28) and the recent test attempts chart (see Figure 29). These are displayed at various locations, and provide self-monitoring by supporting the primary task in the system. All three implementations visually represent different levels of abstraction for learning performance. Students can quickly digest high-level information about their overall performance using the progress bars, which can then be progressively broken down into the low-level details of attempts made for a specific test. This scale of visual representation of progress provides personalisation and a light implementation of reduction, as students do not have to expend great efforts to quickly understand how they are performing at various levels. Students can also easily set goals for themselves using these data, thereby implementing the aforementioned study strategy. This is a valuable feature considering that students are likely to use the system in bursts, particularly if they have external work commitments. The ability to quickly make students aware of what stage of their course completion they reached previously and remind them of their overall progression is crucial to effectively trigger students to re-engage with coursework. This means less time and effort is expended on re-acquainting students with that they should be doing more time and effort can be dedicated to completing coursework.

<table>
<thead>
<tr>
<th>Course test completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course completion is calculated by counting the amount of tests where you received a score of 80% or higher, over the total amount of available tests.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Course</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Business</td>
<td>98%</td>
</tr>
<tr>
<td>Sys. Dev.</td>
<td>45%</td>
</tr>
<tr>
<td>Social Science</td>
<td>80%</td>
</tr>
<tr>
<td>Mobile Sys.</td>
<td>60%</td>
</tr>
</tbody>
</table>

*Figure 27: Progress bars representing course completion in TTM*
The most basic view of student progress in TTM is found in the performance section, where students can see how much of they have completed for each course using TTM (see Figure 27). To register as completed, students must score 80% or higher. The figure of 80% is set in accordance with the mastery learning theory (Block & Burns 1976), but it also acts as an unintended persuasive feature by indicating a suitable goal for students to achieve. In addition, The progress bars leverage the idea of goal gradients, where people are inclined to see something reach completion and often work harder to achieve this the closer they get to the target (Kivetz, Urminsky & Zheng 2006). Although the 80% result to register as complete and the nature of progress bars are individually subtle in design, they should have a positive persuasive effect of motivating students to continue working throughout a semester.

If students have not made as much progress as they had thought or expected, TTM enables them to view their average test performance per week and the highest results attained for each test for a week (see Figure 28). This helps students diagnose where they may be behind in their coursework. Although not originally designed with this intention, it can be argued that these charts provide a small amount of verifiability, specifically for the overall course completion progress bars. That is, students may incorrectly assume they have completed a large number of tests (which may be true) but they may not have received a score of 80% or higher. Hence, they can look through the performance bar charts to verify whether their assumption is true. Students’ self-perception of their ability or performance can be incorrect,
and so this feature helps instil trust that the data shown are valid and accurate. Not providing this functionality in TTM could undermine the data credibility, at least for students.

*Figure 29: Recent attempts of tests in TTM*

Once a student has determined where they may need to improve, they can inspect the recent attempts charts for the corresponding test. The chart appears at the top of the course content page so that every time students return to the page, they are reminded of their previous attempts for that week’s tests. An example can be found in Figure 29. If the last attempt resulted in a low score, the intention is to spark interest in re-attempting for a higher score to ultimately reach a state where all questions are correctly answered. The use of a line to represent the data rather than a bar is so that students can more easily see the trend or pattern in their attempts. If the line inclines positively, then it indicates that the student’s understanding is improving. Students being in this positive scenario should improve the motivation aspect of the FBM, raising the likelihood of other system triggers being effective at promoting completion of further tests or tasks. Presumably, students would understand that if the slope is negative or constant, then they need to revise their understanding of the topic or seek advice from the instructor on how to improve. However, as the level of metacognition in students varies, some may not draw this conclusion from viewing the charts, so TTM also implements study tips that promote good study strategies, which was completed as part of this research.
6.3.4 Study tips

To improve motivation in students working throughout the semester, helpful messages/study tips are placed at the top-right-hand corner of the screen throughout the system. This feature was newly implemented by this research to enhance dialogue support through suggestion. The content of the tips is based on the impactful study behaviours identified in phase 1 (see Chapter 4). Table 14 provides examples of the tips (see Appendix D for full list). The tips were derived from the self-perceived model of study behaviour. Item 1 was found to positively correlate with self-perceived academic performance and involved obtaining information from multiple sources. The related TTM study tip raises awareness of this concept to students and provides examples of how students may achieve this goal.

Table 14: Examples of motivational messages and a tip in TTM

<table>
<thead>
<tr>
<th>Behavioural Analysis Item</th>
<th>Tip or Motivational Message</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 When I study for a class I pull together information from different sources, such as lectures, readings and course materials.</td>
<td>Be resourceful How many places are you looking for information from? Make sure you cover a range of sources, such as lecture notes, readings and other course materials.</td>
<td>Tip</td>
</tr>
<tr>
<td>2 I often get so lazy or bored when I study for a class that I quit before I finish what I planned to do.</td>
<td>Persistence pays off Feeling lazy or bored while studying? Don’t give up! TTM believes in you!</td>
<td>Motivational message</td>
</tr>
<tr>
<td>3 When a subject’s work is difficult, I either give up or only study the easy parts.</td>
<td>Keep with it Studying the easy parts is a great confidence booster, but studying the hard parts is what will improve your grades.</td>
<td>Tip</td>
</tr>
</tbody>
</table>

In total, 21 individual study tips were crafted by the researcher, with some items from the study behaviour models appearing multiple times. TTM selects a random tip from this pool and displays one every time students open a page in the system (see Figure 30 for example displays). The placement of the tip in the top-right-hand corner means it does not get in the way of the user’s primary goal of completing tasks and tests. Thereby, the tips conform to the unobtrusiveness postulate of the PSD framework.
6.3.5 System use: credibility and authority

TTM is designed to be persuasive in the ways that it operates, particularly in the process of how students use the system. Accessing the system requires students to log in with their university accounts, enabling two persuasive system qualities: personalisation and surface credibility. The system greets students by name and all the information presented belongs to the individual student, such as their course enrolments. This creates a personalised working environment. At login, students are presented with the standard university login screen, providing a sense of familiarity and trustworthiness. The fact that students log in with their university accounts implies that TTM is a legitimate application. This results in an increased sense of surface credibility. Instructors are asked to perform check-ups every two to three weeks and have students demonstrate what they have completed in TTM. This leverages the inherent authority of the instructors to encourage students to complete coursework. Without instructor encouragement, students may lose interest in using TTM because a lack of insistence for its use can be interpreted as the system lacking importance. This interpretation could be due to the limited time students have to complete their studies: they are unlikely to prioritise simply experiment with TTM.

6.4 Mobile-based Component: Study Helper

It is difficult to generate interest in a system solely through a web-based app, particularly when students are not on campus. A mobile app, however, can extend a system’s reach. This section describes Study Helper, the mobile app component of TTM, which was built specifically for this research.
The web-based intervention described in section 6.3 implements several PSD system quality categories and related study behaviours and strategies. However, one category it does not cover strongly is dialogue support. Dialogue support is intended to provide greater levels of human-computer interaction for the user. Dialogue support has been identified as an important component of successful persuasive systems by reminding users of the task can help sustain motivation to continue using the system (Lehto & Oinas-Kukkonen 2015). The system design could be improved by a more direct connection with students at times when they are away from the system. It is anticipated that for the majority of time the TTM system is used by students in class, and is otherwise used sporadically to fit with students’ schedules. Given that TTM competes for time with other activities, it is desirable to have a mechanism to remind students to complete tasks and tests. To enable this, the Study Helper mobile app was built and directly tied in with TTM to allow for direct communication with students through push notifications. Push notifications are simple messages sent to the user that can help trigger task commencement and test completion.

Study Helper serves as a companion to the TTM web system. It features all the visualisation found in TTM, with the only point of difference being the lack of task and test submission in the mobile app. This lack is deliberate since Study Helper is intended to be used only in addition to TTM. TTM is designed to allow study for a somewhat extensive amount of time, in which students are more likely to be at a desk and committed to studying topics that may need them to refer to other materials. Making the web and mobile apps identical would have implied that all of the tasks are simple and can be done anywhere. However, this is not true for all tasks; for example, one course involves programming tasks using Visual Studio, which is desktop software. If Study Helper allowed these tasks to be downloaded even though they could not be performed on a mobile, this would violate the second postulate of the PSD: that people like the world to be organised and consistent.

6.4.1 Mobile app features

A key feature of Study Helper is the ability for students to receive push notifications from instructors or TTM itself. The messages contained in the push notifications can range from reminders of upcoming assessments to prompts for students to think about whether they have completed that week’s work. An issue with sending push notifications for any app is that once the message has been viewed, it cannot be stored. This would cause problems for Study Helper because a student may unintentionally dismiss a notification and then forget to
perform the desired action from the message. To address this, Study Helper has a message centre not found in the web version of TTM. In the message centre, students can revisit any message delivered to them (see Figure 31). Further, when a student opens a notification (or selects it from the message centre) the app can take the student directly to a specific location inside the app. This is particularly useful when the system or instructor wishes to point out a particular piece of information to students. For example, if a student receives a notification regarding their recent attempts for a certain test, the notification (when opened) can lead the student directly to the chart displaying this information. This is intended to act as a trigger to perform an action, even if the action is not explicitly stated in the message.

![Image](image-url)

**Figure 31: User receiving a push notification in Study Helper**

Study Helper, like TTM, uses visualisation to represent data about students’ performance. As well as implementing the same progress bars, line charts and bar charts found in TTM, the researcher built a quick status feature was in to Study Helper. The quick status appears as a badge placed next to the course code on the welcome screen of Study Helper (see Figure 32). It can be one of three colours representing how students are tracking in the course: green means “Up-to-date”, amber means “Work to do” and red means “Falling behind”. This deliberately matches the standard traffic light format that is commonly known. The traffic
light format makes it easy for students to quickly see and understand their current performance level in a manner that does not require any explanation. This is particularly important for Study Helper; since it is not expected that students will spend a lot of time using the app, messages must be conveyed extremely efficiently. The quick status can also be considered an indirect persuasive message route (as per the PSD postulates), so being clear in meaning is very important in order to avoid students becoming confused about what is expected by the system or instructors.

![Quick status feature in Study Helper](image)

*Figure 32: Quick status feature in Study Helper*

### 6.5 System Triggers and Overall Persuasive Design

This chapter has so far discussed the design of the web and mobile components, which form part of the overall DLE system in this research. This section details how the system operates as a single entity. Although core components of the system are persuasive, behaviour changes still need to be compelled, which can be achieved using system triggers. Without triggers, the system is static and would require great effort from the instructor to encourage students to act in the system. Simply implementing standard triggers would be unlikely to result in successful persuasion, which is why the FBM was used to guide the design and
implementation of triggers. The FBM describes the relationship between ability and motivation and suggests that when sufficient levels of both exist for a user, a trigger is likely to succeed. The following persuasive features in TTM—bite-sized tasks and tests, an automatic to-do list, visualisation, the use of authority to instil credibility and the push notification system—can be assessed through this lens.

Lengthy tutorial tasks pose challenges to student ability and motivation. The tasks themselves are often difficult since they are designed to develop the fundamental skills that students require to complete the course content. If the level of difficulty is too high, the learning system relies entirely on students’ own motivation to persevere. This reliance is becoming less feasible, particularly as students are increasingly busy and looking to make more efficient use of their time and effort wherever possible. For students to be successfully triggered to complete tasks, it is necessary to break down large tutorials into smaller bite-sized pieces. This reduces effort, raising students’ ability. The visual representation of test results (in progress bars and recent attempts charts) provide the motivation to continue improving. Thus, the recent attempts chart, situated at the top of the content page, can act as an effective trigger in encouraging students to continue working towards completing the tasks and tests. Keeping track of the tasks and tests that need to be completed may be challenging for students in the long term, which is where the automated to-do list can be useful.

Although a to-do list can encourage tasks to be completed, its effectiveness as a trigger relies on a mix of student ability to manage their workload and motivation. Managing a to-do list is a simple task and one that most students would be capable of handling. However, as time passes, keeping the list up-to-date becomes more involved and could be perceived as a chore. Hence, as the semester progresses and student workloads increase, the likelihood of students maintaining the list diminishes. In line with the FBM, a reasonable solution would be to lower the effort required to maintain the to-do list, so that it is more in line with student motivation. This is what automation of the list in TTM achieves.

To address the issue of motivation, TTM uses visualisation such as line charts that indicate the recent results of a test. When students view their recent history charted as a line graph, the trend is far easier to interpret than in an equivalent tabular format. An upward trend may motivate students to keep working towards a perfect score, and a downward trend may encourage them to work harder. Addressing both ability and motivation in this way creates an environment where a trigger will likely be effective. In this situation, TTM’s trigger is
implemented through the Study Helper push notification system. This prompts students by asking if they have checked their to-do list recently, and directs them to the recent history chart for a test. While this is expected to make an effective technological trigger, instructors performing regular check-ups in class can also ensure that performing the action of completing tasks and tests is worthwhile for students. That is, it provides credibility for push notification triggers as instructors in the role of authority will be enquiring about course progress. By converging all of these persuasive features, students should be influenced to continue submitting coursework.

6.6 Summary

This chapter presented two components of the overall DLE and discussed their persuasive design elements. The components included the original TTM system with the addition of newly added study tips, and an entirely new mobile app named Study Helper. The findings of both phases 1 and 2 were combined with a discussion about how the persuasive system qualities in the TTM system are used to support some of the positive study behaviours identified in phase 1. It is expected that the combination of bite-sized tasks and tests, an automated to-do list, visualisation of progress and the direct communication of messages through the Study Helper app will lead to TTM being persuasive in encouraging students to engage with their coursework. The next chapter evaluates the persuasiveness of the system based on its use by students.
Chapter 7: Results and Discussion

7.1 Overview

This chapter presents the results of the analysis of the quantitative and qualitative data collected. It then discusses the findings of how persuasive students from various undergraduate courses perceived TTM to be. There are two aims for this chapter: to develop a persuasive learning model and to postulates for designing persuasive learning systems. To achieve these aims, several data analyses are conducted, beginning with descriptive statistics methods on self-reported survey data to determine whether TTM was perceived to be persuasive. A factor analysis of the quantitative survey data is used to identify the factors responsible for the perceived persuasiveness. To provide further depth, a thematic analysis is conducted on the qualitative interview data collected from eight student participants and prominent themes extracted. To understand how the themes relate to each other and assist with developing general postulates for persuasive learning systems, the themes are analysed using word clustering. This process highlights underlying relationships in the topics discussed by participants and assists with the construction of a persuasive learning system model and postulates for future persuasive learning system designs. Table 15 summarises the data analyses and sources.

Table 15: Summary of analyses

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptive statistics</td>
<td>Survey</td>
</tr>
<tr>
<td>Factor analysis</td>
<td></td>
</tr>
<tr>
<td>Thematic analysis</td>
<td>Interview transcripts</td>
</tr>
<tr>
<td>Thematic correlation</td>
<td></td>
</tr>
</tbody>
</table>

7.2 Results

Students used TTM in class for the duration of an entire semester of 12 weeks. It was explained to students in the first week of classes that they were to access the tutorial tasks and tests each week and complete them. TTM was used in several business information systems courses, including Systems Development, E-Business and Mobile Systems, as well as in Research Methods in Social Science courses. Each course integrated its learning materials
into TTM to varying degrees. For example, the mobile app design course was constructed from the ground up to align with the TTM design principles of micro-learning, whereas the material for the e-business course was decomposed into bite-sized tasks and tests from existing traditional tutorial material. Students were given general recommendations to first complete the task and then complete the test, in that order. Instructors were asked to provide regular consultations every two to three weeks to monitor whether students were completing work and to address any concerns they may have. At the conclusion of the semester, students were invited to complete a survey about their experience of using TTM. They were also invited to volunteer for participation in interviews.

7.2.1 Survey

The survey was distributed at the end of the semester. There were 69 total respondents across all the courses using TTM. Eight of the 69 responses were not sufficiently completed and were excluded, leaving 61 usable samples. The data collected skewed heavily towards males and students aged between 18 and 25 and were predominantly full-time local students, which is representative of the general population of students in Information Technology related programs (DET 2016). The survey was also open to students in Social Science programs, however the majority of respondents were from the information systems programs and so it is not expected that the demographic representation will substantially impacted. Table 16 summarises the demographics of the survey respondents.
Table 16: Demographics of survey respondents

<table>
<thead>
<tr>
<th>Demographic</th>
<th>% of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>67</td>
</tr>
<tr>
<td>Female</td>
<td>33</td>
</tr>
<tr>
<td>Student type</td>
<td></td>
</tr>
<tr>
<td>Local</td>
<td>73</td>
</tr>
<tr>
<td>International</td>
<td>27</td>
</tr>
<tr>
<td>Study load</td>
<td></td>
</tr>
<tr>
<td>Full-time</td>
<td>85</td>
</tr>
<tr>
<td>Part-time</td>
<td>15</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>18–21</td>
<td>45</td>
</tr>
<tr>
<td>22–25</td>
<td>35</td>
</tr>
<tr>
<td>26–29</td>
<td>6</td>
</tr>
<tr>
<td>30–39</td>
<td>8</td>
</tr>
<tr>
<td>40+</td>
<td>6</td>
</tr>
<tr>
<td>Program</td>
<td></td>
</tr>
<tr>
<td>Bachelor of Business/IT</td>
<td>69</td>
</tr>
<tr>
<td>Other (Social Sciences)</td>
<td>31</td>
</tr>
<tr>
<td>Course</td>
<td></td>
</tr>
<tr>
<td>Systems Development</td>
<td>25</td>
</tr>
<tr>
<td>E-Business</td>
<td>40</td>
</tr>
<tr>
<td>Mobile Systems</td>
<td>21</td>
</tr>
<tr>
<td>Research Methods in Social Sciences</td>
<td>13</td>
</tr>
</tbody>
</table>

7.2.1.1 Use of Task-Test-Monitor

When examining the data collected on TTM usage during the semester, it was found the system was regularly used, with 16% of students using it more than five times per week, 30% using it three to four times per week and the majority (46%) using it at least one to two times per week (see Figure 33). Without further examination, this at least suggests that TTM was useful and easy to use for students, given that 92% of respondents used it regularly throughout semester. Regular use is a requirement for a system to be considered persuasive, and the data suggest that regular use was true of TTM. Further, 72% of respondents stated
that they would like to see TTM used in their other courses (see Figure 34). Intention to use a system in the future is a factor in the technology acceptance model (Davis, Bagozzi & Warshaw 1989), which strengthens the argument that TTM is a system that meets student needs for their DLE.

Respondents were also asked whether TTM assisted them with managing their time for the course (see Figure 35), with 48% of respondents stating that it did help them manage their time. This is an encouraging result since one negative study behaviour identified in phase 1 involved students struggling to stick to study schedules. This result indicates that TTM may have had some level of influence in helping students manage this process. However, 37% of respondents were unsure of whether this help occurred, so further understanding needs to be deduced from the thematic analyses.

![Figure 33: Frequency of TTM use](image)

Figure 33: Frequency of TTM use
7.2.1.2 Task completion

Analysing the lower-level details of system usage, the survey results showed that 67% of students regularly completed the tasks (either most of the time or all of the time - see Figure 36), which represents a positive result for TTM’s ability to encourage task completion. Task completion is optional in TTM as it forms part of the foundation coursework and therefore is
not assessed. Only 3% of students never completed the tasks. These students either were not satisfied with the content or had other issues regarding their study that may have adversely affected their ability to complete tasks. Unsurprisingly, given the active use of TTM, 95% of respondents found the tasks to be at least “somewhat useful”. While 5% did not find them useful at all (see Figure 36), it should be noted that only 3% never submitted the tasks (see Figure 37). This implies that 2% of the respondents did not find the tasks useful but still completed them. This could be a very minor indication of TTM’s persuasive ability in encouraging students to at least attempt some coursework, even if it appears to not be beneficial in the minds of these students.

![Figure 36: Frequency of task completion in TTM](image)

Figure 36: Frequency of task completion in TTM
7.2.1.3 Test completion

Following the high levels of completion of tasks, many respondents (97%) also completed the tests, albeit for varying reasons (see Figure 38). The multiple-choice tests were arguably the most flexible component in TTM as they could be completed either before or after a task, lecture or tutorial class as well as for revision. The most popular method of completing tests by respondents was after the tutorial class, which suggests that they would use the time in class to complete the task, and then test their knowledge afterwards. Two interesting results from the data are the number of respondents who stated they took the tests earlier in the semester and then stopped, and the number of respondents who used the tests to catch up on their studies. This indicates that time management is an issue for students, as 22% stopped completing tests after some time. This could be a result of the optional nature of the tests, coupled with an increasingly heavier workload being placed on students as the semester progresses. Students may be opting to skip the tests to regain control of their time. It is unlikely that the TTM system or the content of the tests caused these respondents to stop since 54% stated that the tests were “somewhat useful” and 43% found them very useful (see Figure 41). Therefore, it is reasonable to conclude that external factors likely led to students either stopping completing tests or needing to catch up on their studies by going back to tests later.
In terms of academic performance, the majority of students (75%) were aiming for a score of 100% when completing tests (see Figure 39). The tests were not assessed and students had unlimited attempts available to them, so a target of 100% for most students suggests that students are intrinsically motivated to perform at the highest level. Only 5% of students “didn’t care” what results they achieved. It could be argued that with no risk, there is no reward, and so the number of students not caring was expected to be higher. Despite 5% not caring about results, 97% of respondents found the tests to be either “somewhat useful” or “very useful” (see Figure 41). While there was nothing to be gained in terms of tangible outcomes such as grades, it is evident that students could make the connection to the knowledge gains they would acquire from completing the tests, which they could then apply to assessments at a later point in time.

When assessed using the FBM, it is clear in this instance that students were highly motivated, and the bite-sized structure of the tests and consequence-free nature of attempts meant their ability to carry out this action was high. This indicates that the recent history charts placed directly above the buttons to access a test may have been an effective trigger in compelling students to attempt the tests and continue doing so until they reached their target of 100%. This can be evidenced by 79% of respondents also stating that they attempted the tests at least two to three times, with 6% attempting them four or more times on average (see Figure 40). This result gives an early indication that students, contrary to popular belief, are not unmotivated to study; rather, it may be more likely that restricting their ability to study hampers their academic performance.
Figure 38: Reasons for completing tests

Figure 39: Test score aims
7.2.1.4 Use of Study Helper

The mobile app component of the TTM system, Study Helper, received a more modest response in terms of use compared to the web-based component of the system. Initial enthusiasm appears to have been high, as 85% of respondents said that they installed Study Helper (see Figure 42). However, this figure can also be attributed to the first task in TTM, which is to set up Study Helper on students’ mobile phones. When asked about the number of
times Study Helper was used throughout the semester on average, the modal amount was “1 to 2 times per week”. Only 7% used the app three to four times per week, and there were no heavy users using it “5 or more times” (see Figure 43). The number of respondents who did not use it at all after installing was 37%, which is indicative of an issue in student engagement with the app. The number of respondents for the option of “not applicable” (13%) did not match the number of respondents who said they did not install the app (15%). This discrepancy may be explained by respondents misunderstanding the second question (number of times used on average) and selecting “0” as an equivalent to not applicable. If true, then the total amount of non-use of Study Helper becomes 50%, which indicates an unfavourable result for the app overall.

![Bar Chart: Did you install the Study Helper app?](image)

*Figure 42: Study Helper app installation*
7.2.1.5 Impact on study behaviour

To this point in the analysis of the survey results, students considered TTM beneficial to their learning, with many engaging with the tasks and tests and a majority wanting to see the system applied in other courses. These are important results and provide a foundation from which the persuasiveness can be evaluated. Without regular use, it would not be possible to assess the persuasive potential of the system. The survey distributed to participants featured several questions that directly measured certain aspects of the PSD. For this part of the analysis, attention is placed on several of the items that clearly represent the influence TTM had on study participants. These items fall into two groups: the studying process and the behaviour related to studying.

Overall, the items selected for this part of the analysis generally showed positive results in terms of TTM’s ability to persuade behaviour. Of respondents, 46% agreed that TTM made them reconsider the way they studied (see Figure 44), and 61% stated that it helped change their approach to study (see Figure 45). Very few disagreed completely (ranging from 10% to 26%) with most of the items; however, there were considerable numbers of respondents who neither agreed nor disagreed that TTM influenced their study process or behaviour. This could be related to the focus of the subject in the sentence. That is, the items about persuading the study process imply that respondents have control over their behaviour and TTM simply helped them achieve it. The questions that lead the respondent to consider how
it made “them” reconsider the way they study and how it changed “my” approach to studying had lower levels of neutrality. Observing the items related to behaviour, the questions propose that TTM directly impacted students’ behaviour, without stating whether a change was desired. That is, TTM encourages them, influences them and instils confidence, which are positive outcomes for the student. Nevertheless, respondents may have had a natural hesitation to admit that a system could have that level of control over them. It may be that students want to believe they are in control over their learning process and TTM is simply assisting them. This is an important finding for persuasive DLE because it indicates that students need to believe they are in control of the influence and not feel like they have been persuade d, even when there is clearly no coercion taking place in a system.

![Graph showing TTM makes me reconsider the way I study](image)

**Figure 44: Reconsidering the way to study**
Observing the items of the survey more closely related to motivation, it should be noted that the items of “TTM encourages me” and “TTM has an influence on me” and “TTM instills confidence” received similar responses, with 47%, 41%, and 50% respectively, of respondents agreeing with each statement (see Figure 46, Figure 47 and Figure 48). These are direct statements of persuasion that can be measured through self-reporting and all were positive overall (excluding neutral results).

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Summarising the descriptive statistics gathered on TTM, it is evident that the system was used regularly and provided ample primary task support to students, albeit mainly through the web-based component of the system. This is validated by the majority of respondents stating they wished to see TTM used in other courses. On the other hand, Study Helper was not as successful in its intended purpose, which was to enhance dialogue support in the system, with many respondents stating they did not use the app at all during the semester. Some individual PSD survey items indicated that TTM overall had a persuasive impact on respondents, with
the system encouraging them to reconsider how they studied and instilling confidence in their ability to study.

7.2.2 Factor analysis

To obtain a deeper understanding of the factors that made TTM persuasive, a factor analysis was performed to uncover the persuasive drivers. Principal component analysis was performed using direct oblimin rotation because the factors were not expected to be entirely independent of each other (Field 2009). Initial results using all 21 items of the PSD survey instrument produced a correlation matrix that identified seven items in which most correlation coefficients were under 0.3, indicating weak relationships, and these items were removed. The seven items were:

- TTM provides me with appropriate feedback.
- TTM is reliable.
- TTM is clearly made by lecturers/tutors.
- TTM is personally relevant for me.
- Using TTM disrupts my daily routines.
- Finding the time to use TTM is not a problem for me.
- Using TTM is practical/convenient for me.

Upon removal of the low correlation items, the determinant was 0.00003743, which is above the recommended 0.00001 threshold (Field 2009). No items were heavily correlated either (above 0.9) and so multicollinearity was not a problem in the dataset. Using eigenvalues greater than 1, SPSS extracted three factors. The three factors were retained after viewing the scree plot, which also had a point of inflexion indicating three factors were present (see Appendix E for scree plot). Of the variance, 69% was explained by the three factors. The reduced item set resulted in a Kaiser-Meyer-Olkin of 0.86 indicating that the sample was adequate. Bartlett’s test of sphericity was also significant for a value of 555.523 (see Table 17).
Table 17: Kaiser-Meyer-Olkin and Bartlett’s tests results

<table>
<thead>
<tr>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</th>
<th>Bartlett’s Test of Sphericity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Approx. Chi-Square</td>
</tr>
<tr>
<td>0.861</td>
<td>555.523</td>
</tr>
</tbody>
</table>

Observing the pattern matrix, each factor had several items that correlated strongly (see Table 18).

Table 18: Pattern matrix produced by SPSS

<table>
<thead>
<tr>
<th>Item</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using TTM fits into my daily life.</td>
<td>0.881</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM has an influence on me.</td>
<td>0.786</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM encourages me.</td>
<td>0.785</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM makes me reconsider the way I study.</td>
<td>0.659</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM instils confidence.</td>
<td>0.645</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM helps me change my approach to studying.</td>
<td>0.563</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM provides me with a way to study.</td>
<td>0.487</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The general appearance of TTM is appealing.</td>
<td>-0.938</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The screens in TTM (i.e., colours, layout, etc.) are attractive.</td>
<td>-0.926</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM provides a nice visual experience.</td>
<td>-0.793</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTM helps me keep up to date with course work.</td>
<td>0.438</td>
<td>-0.520</td>
<td></td>
</tr>
<tr>
<td>TTM is trustworthy.</td>
<td></td>
<td></td>
<td>0.950</td>
</tr>
<tr>
<td>TTM shows expertise.</td>
<td></td>
<td></td>
<td>0.726</td>
</tr>
<tr>
<td>TTM provides me with appropriate counselling.</td>
<td></td>
<td></td>
<td>0.439</td>
</tr>
</tbody>
</table>

Finally, each of the factors’ items were tested for reliability, as were the total items combined. All resulted in Cronbach’s alpha scores of at least 0.7, indicating good internal reliability (see Table 19).
Table 19: Item reliability results

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of Items</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>0.887</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>0.889</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.778</td>
</tr>
<tr>
<td>Overall</td>
<td>14</td>
<td>0.922</td>
</tr>
</tbody>
</table>

The analysis uncovered three factors leading to persuasion: guidance, visualisation and learning support. The first factor included PSD constructs that mostly derived from primary task support and perceived persuasiveness, followed by unobtrusiveness, dialogue support and credibility support. The factor was labelled “guidance” because the items related generally to learning strategy and motivation to learn. The second factor very strongly grouped items regarding appearance and user interface and so was labelled “visualisation”. The third factor featured a mixture of credibility and dialogue support. The concepts of trustworthiness, expertise and counselling could be drawn from the role of the instructor in a class, and so this factor was labelled “learning support”. A summary of the items extracted, the associated labels and the PSD construct that the item originated from can be found in Table 20.
### Table 20: Factor summary

<table>
<thead>
<tr>
<th>Factor Label</th>
<th>Item</th>
<th>Original PSD Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Guidance</td>
<td>Using TTM fits into my daily life.</td>
<td>Unobtrusiveness</td>
</tr>
<tr>
<td></td>
<td>TTM has an influence on me.</td>
<td>Persuasiveness</td>
</tr>
<tr>
<td></td>
<td>TTM encourages me.</td>
<td>Dialogue</td>
</tr>
<tr>
<td></td>
<td>TTM Makes Me Reconsider The Way I Study.</td>
<td>Persuasiveness</td>
</tr>
<tr>
<td></td>
<td>TTM instils confidence.</td>
<td>Credibility</td>
</tr>
<tr>
<td></td>
<td>TTM helps me change my approach to studying.</td>
<td>Primary Task</td>
</tr>
<tr>
<td></td>
<td>TTM provides me with a way to study.</td>
<td>Primary Task</td>
</tr>
<tr>
<td>(2) Visualisation</td>
<td>The general appearance of TTM is appealing.</td>
<td>Design aesthetics</td>
</tr>
<tr>
<td></td>
<td>The screens in TTM (i.e., colours, layout, etc.) are attractive.</td>
<td>Design aesthetics</td>
</tr>
<tr>
<td></td>
<td>TTM provides a nice visual experience.</td>
<td>Design aesthetics</td>
</tr>
<tr>
<td></td>
<td>TTM helps me keep up to date with course work.</td>
<td>Primary Task</td>
</tr>
<tr>
<td>(3) Learning Support</td>
<td>TTM is trustworthy.</td>
<td>Credibility</td>
</tr>
<tr>
<td></td>
<td>TTM shows expertise.</td>
<td>Credibility</td>
</tr>
<tr>
<td></td>
<td>TTM provides me with appropriate counselling.</td>
<td>Dialogue</td>
</tr>
</tbody>
</table>

#### 7.2.3 Thematic analysis

To provide more depth of understanding to the factor analysis, eight students were recruited to participate in individual interviews based on their experience of using TTM during the semester. The participants included students from each course that used TTM, both males and females, as well as an international student and two mature-aged students. This was representative of the population that used TTM. Table 21 summarises the demographic details. The interviews focused on which TTM features participants interacted with and the effect those features had on their motivation to complete coursework. The interviews were transcribed and coded in a descriptive manner. The codes were then combined into themes, which are summarised in Table 22. Seven themes were discussed in all eight interviews, indicating that saturation had been achieved (see Figure 49).

This section discusses the main themes that arose during the interviews. It then focuses on topics of interest to the aim of this research: the three factors identified in the factor analysis,
Study Helper and the learning strategies employed by the participants which was the theme most coded in the interview transcripts (see Figure 50).

*Table 21: Demographics of interview participants*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Program</th>
<th>Course</th>
<th>Gender</th>
<th>Age</th>
<th>Student Type</th>
<th>Study Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Social Sciences</td>
<td>Research Methods</td>
<td>Male</td>
<td>40+</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>2</td>
<td>Bachelor of Business</td>
<td>Systems Development &amp; E-Business</td>
<td>Male</td>
<td>22–25</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>3</td>
<td>Bachelor of Business</td>
<td>Systems Development &amp; E-Business</td>
<td>Male</td>
<td>22–25</td>
<td>Int.</td>
<td>Full-time</td>
</tr>
<tr>
<td>4</td>
<td>Social Sciences</td>
<td>Research Methods (Online)</td>
<td>Female</td>
<td>22–25</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>5</td>
<td>Bachelor of Business</td>
<td>E-Business</td>
<td>Male</td>
<td>18–21</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>6</td>
<td>Social Sciences</td>
<td>Research Methods</td>
<td>Female</td>
<td>40+</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>7</td>
<td>Bachelor of IT</td>
<td>Systems Development</td>
<td>Male</td>
<td>18–21</td>
<td>Local</td>
<td>Full-time</td>
</tr>
<tr>
<td>8</td>
<td>Bachelor of Business</td>
<td>Systems Development</td>
<td>Male</td>
<td>26–29</td>
<td>Local</td>
<td>Full-time</td>
</tr>
</tbody>
</table>
Table 22: Themes extracted from interview data analysis

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning strategy</td>
<td>How respondents approached studying.</td>
</tr>
<tr>
<td>TTM</td>
<td>Either the web-based features or the overall system.</td>
</tr>
<tr>
<td>Assessment</td>
<td>Grades, assignments, etc.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Desire to study, complete tasks, achieve grades, etc.</td>
</tr>
<tr>
<td>Social</td>
<td>Comparing to others in class, social motivation, pressure, etc.</td>
</tr>
<tr>
<td>Guidance</td>
<td>Primary Task Support for learning.</td>
</tr>
<tr>
<td>Visualisation</td>
<td>Charts and graphs or aesthetics in general.</td>
</tr>
<tr>
<td>Persuasiveness</td>
<td>Direct mentions of how the system influenced study behaviour.</td>
</tr>
<tr>
<td>Learning environment</td>
<td>The broader learning environment. Could be system or physical.</td>
</tr>
<tr>
<td>Education</td>
<td>Qualifications, skills, etc.</td>
</tr>
<tr>
<td>Study Helper</td>
<td>The mobile app.</td>
</tr>
<tr>
<td>Support</td>
<td>Help with learning.</td>
</tr>
<tr>
<td>Recognition</td>
<td>Being recognised for effort, typically academic.</td>
</tr>
<tr>
<td>Employment</td>
<td>Jobs, careers and applicable skills.</td>
</tr>
<tr>
<td>Ability</td>
<td>Personal capability of achieving academically.</td>
</tr>
</tbody>
</table>

Figure 49: Frequency of theme discussion across interviews
A common occurrence in the interviews was the discussion of learning strategy, which was mentioned 161 times across all interviews. The next three most discussed themes were TTM, assessment and motivation. This is an interesting combination since TTM is a system for unassessed coursework, yet assessment was discussed almost as frequently as TTM. The reason for this may lie in the discussion of motivation since students perceived that usage of TTM was likely to increase their performance on assessments. The emergence of these four themes is consistent with the argument proposed in Chapter 1: that students’ main priority at university is to complete courses and graduate, and that students are leading busier lives away from academia. The results of the thematic analysis indicate that students are strategising their approach to study by using TTM to acquire the specific knowledge they require for assessments. This also explains another group of themes that were discussed: education, recognition and employment. Participants mentioned that one of their goals when undertaking a course was to acquire skills and knowledge that could be practically applied elsewhere, such as in employment.

In terms of recognition, participants mentioned badges and rewards as acknowledging their efforts in studying. These may be useful to consider for future integration into TTM. Another group of themes that appeared in the interviews was guidance, visualisation and support, matching the factor analysis. Study Helper was also discussed during the interviews, although
not all participants used the app. Those who did reported similar issues to those derived from the survey analysis.

7.2.4 Thematic correlation

The thematic analysis provided more depth to the understanding of student learning strategies and the three factors extracted from the survey data. This section assesses the themes at a finer level and identifies correlations between the words used by participants in the themes that were coded. This provides a better understanding of related themes, which will also help construct an overall model for how persuasion occurs in TTM. As shown in Figure 51, there are many relationships that the qualitative analysis software identified. The relationships of interest include TTM being linked with guidance, visualisation and support, further supporting the factors that were extracted. Visualisation is linked to motivation and learning strategy. TTM, persuasiveness and learning strategy are also linked. Social is linked to motivation and learning environment.
Four themes identified as related in the thematic relationship analysis did not have strong correlations with any other theme: ability, education, employment and recognition. This is an unexpected result since these themes would have been anticipated to be described together, given the broad goal of students prioritising assessments to obtain degrees to find employment in their field. The themes also follow a logical sequence that occurs in reality. Students improve their ability through skills development and knowledge acquisition by enrolling in a program, and their efforts for doing so are recognised when they are given good grades. This in turn improves the likelihood of being employed. This path is arguably the general one that all students take, although some students may be more concerned with individual parts of that process. For example, students who are intrinsically motivated to study may be more concerned with ability and education, whereas extrinsically motivated
students may devote more time to ensuring they gain employment and recognition. The inability to identify any relationships in the data for these themes could be a limitation of the dataset; however, it may also be due to similar reasons to those given for the differences in study behaviours of current students and alumni from Chapter 4. That is, the themes of ability, education, employment and recognition represent the end goal for students. Although they are working towards achieving these goals generally, their focus during a semester is on the lower-level skills and knowledge acquisition process: this can be referred to as their learning strategy. Education, employment and recognition are the broad direction that students are building towards, which is why they seek guidance through educational institutions and digital learning systems—they trust that doing so will lead them there. The themes themselves may not have been consciously discussed at length by the students when interviewed, but they still appeared when students discussed other themes because students were still aware of their long-term goals.

The correlation of strategy to assessment was expected since formal qualifications are awarded based on performance in assessments. However, an interesting finding from the correlation analysis is that assessment was not correlated with motivation. Instead, motivation was linked to social, TTM, visualisation, guidance and learning environment. One explanation for the lack of correlation between motivation and assessment could be that the classical understanding of ensuring work is assessed to motivate students to complete it may not be entirely correct. Some participants expressed this sentiment when they explained that they did not always complete the unassessed TTM tasks and tests because they were not assessed. However, an alternative view could be that knowing something is going to be assessed does not prompt students to work harder; rather, it is an indicator that something is required to be completed to progress through the course. This is why PSD is proposed as a solution to the lack of enduring engagement in DLE. If assessment alone drove motivation to engage with coursework, then there would be no need for persuasive design. Students prioritise their time on assessed work because it needs to be done, not necessarily because the assessment or grades are motivating in and of themselves. Grades can be defined as an extrinsic motivator, which is typically not as effective as an intrinsic motivator.

The TTM system did not feature any deliberate implementation of the social support PSD construct. However, interview participants were asked a number of questions about hypothetical social features and how they thought that might impact their motivation and
ability to study. A question was asked for each of the system qualities found under social support in the PSD. This was in addition to any other unprompted discussion of social influence by the participant. The results indicate that participants connected the theme of motivation to social as well as learning environment, despite a lack of social features being implemented. Social influence in the learning environment can have a large impact, particularly when comparing students who are on campus to distance learners. For example, the interview participant who was an online student did not believe social comparison would be effective because she had not met any of her classmates and so there was no perceived peer pressure to contend with. However, students who were on campus had a more positive view of how social motivation may operate, possibly because they were in physical proximity to other students. This represents an opportunity for future work to investigate the role of social motivation in a persuasive next-generation DLE (described further in section 8.7).

7.2.5 Summary of results

TTM was generally perceived to be a persuasive learning system by students. The areas of guidance, visualisation and learning support were significant factors contributing to TTM’s persuasiveness. The thematic analysis highlighted learning strategy, the TTM system and assessment as the most discussed themes during the interviews. The factors of guidance, visualisation and learning support were also mentioned during the interviews, albeit at a lower frequency. This indicates that while these factors were significant in terms of understanding what persuaded the students, students were still more concerned with their own goals.

7.3 Discussion

The results of the mixed-methods data analyses provide a rich source of discussion. In this section, the factors of guidance, visualisation and learning support are the perspectives through which the results are examined. One purpose of this discussion is to address the research questions by identifying postulates for designing a persuasive learning system. First, an overall model for persuading students to engage with coursework is presented, which is then used as a platform from which to extract postulates. A discussion of the postulates explores the evidence of the relationships between students, instructors, the system and the factors. Figure 52 summarises how the outcomes are synthesised.
7.3.1 Persuasive learning cycle model

Combining the results of the data analyses allows the development of a model of how persuasion functions in the TTM system. The model is intended to be viewed from the students’ perspective since they are the people to be persuaded. At a high level, it is hypothesised that a persuasive learning cycle exists, driven by guidance and visualisation, with the learning support factor provided by instructors, ensuring that students remain clear on what their goals are and are helped when needed. Based on the data analysed, there are a number of components that enable the cycle. In terms of operation, the cycle begins with students seeking guidance to achieve their goal. This is followed by a visual representation of data on how they are progressing towards their goal. Instructors monitor student behaviour and intervene when necessary to maintain the cycle of seeking guidance and displaying motivating visual feedback. Figure 53 depicts the overall process of the persuasive learning cycle. A discussion of the role each of the factors has in the model follows.
7.3.1.1 Role of guidance in TTM

As the model is student-centred, the first step involves students seeking guidance to achieve their study goals. Observing the factor analysis results, the strongest item in the guidance factor relates to unobtrusiveness rather than primary task support. This suggests that even if the system helps students carry out their primary task of studying and is persuasive, it first needs to integrate into their daily lives. As discussed, students are leading increasingly varied lives, particularly by working while studying, so it stands to reason that students first desire a system that can work within those constraints while still providing support for their main goal—that is, to progress through their university program. The bite-sized tasks and availability of TTM are presumed to have been the main drivers of this result being so prominent, as students could complete tasks and tests at any time that suited them. Viewed through the lens of the FBM, reducing effort may also have had a direct impact on motivation since the system better triggered students to complete the tasks and tests as there was less
reason to avoid completing them. The system catered to students’ requirements, enabling the persuasive encouragement to have a larger impact.

Results indicate that students want TTM to provide them with direction to achieve their study goals, and to deliver the course content in a manner that can be easily scheduled around their work commitments. As workload increases, students want encouragement to continue working towards their goal for the course. The constructs and items found in the guidance factor can also be compared to other popular activities, such as personal training and television viewing habits popularised by services such as Netflix. Much like those two examples, it appears that students viewed the role of TTM (and indirectly DLE in general) as being a service that helps users achieve their goals by aligning with their schedule and encouraging them to reach their goal. An example of this in the context of personal training is a situation where someone’s main goal is to try to lose weight, so they hire a personal trainer to guide them through the process. Personal trainers typically cater to their clients’ schedules, provide direction for how to complete exercises and motivate their clients to continue working towards designated goals. The delivery of course content is similar to the delivery of some television shows, where many people now prefer to “binge watch” complete series of shows in one sitting or watch on-demand at times they prefer (Matrix 2014). This attitude is also found in TTM, with students wanting to control how much of and when they completed their tutorial tasks and tests. When considered as a whole, it is evident that there is a shift in attitude regarding systems, be they computer or human-based, where the user wants to be guided in what needs to occur and still have the flexibility to engage when desired. This has both positive and negative implications for persuasive systems. On the plus side, it indicates a potential avenue for persuasion, in that people trusting a system to guide them can allow for more effective tunnelling to occur. However, the on-demand nature of this guidance means that finding the initial trigger for action may be more difficult for designers because the user determines when they begin contemplating using the system.

As students are limited for time and want to learn what they need in a just-in-time manner, they seek guidance from the system to tell them what they should be doing next. In TTM specifically, students are guided by the automated to-do list that shows which task and tests they are yet to complete, as they are numbered and broken down into small pieces. Students want a system to help direct them through a course, particularly when they become overwhelmed with assessed coursework and, possibly, external employment commitments.
This provides opportunities for a learning system to become a persuasive recommender system. If users of a system are seeking guidance on what they need to do, there is an implied trust that whatever is suggested is useful for the user to do to achieve their goals. This further explains why one of the PSD postulates is that a persuasive system needs to align with users’ goals (Oinas-Kukkonen & Harjumaa 2009). The obvious explanation is so that the system is not coercing or forcing the user to do something that would not be useful. However, the results of this research also indicate that it is necessary to ensure that the user will follow through with performing the actions intended by the designer. Linking this to the FBM, it is clear that the issue of engaging with coursework is not simply explained by the common belief that students lack motivation. Rather, students lack the ability to manage their time and prioritise. When TTM reduces the effort required in “maintaining a study schedule”, which was one of the behavioural issues identified in phase 1, the trigger of encouraging students to complete coursework is more effective. In more general terms, the factor of guidance provides an opportunity to persuade, as users want the system to provide direction in what they want to achieve. From there, the system can recommend what to do. Incremental persuasion can then occur through the recommendations the system makes.

7.3.1.2 Role of visualisation in TTM

The relationship between the user and the guidance factor is only one part of the persuasive loop that exists in TTM. The second relationship can be found in the role that the visualisation factor has with students. In TTM, heavy use of charts, graphs and progress bars were reported by students to influence how they approached their study. Students reported that they wanted to see the bars at or nearing full completion, and that they made them aware of how they are performing. An absence of data was also persuasive for students because it clearly indicated to them that they had not completed any work. Visualisation was viewed as a quick-and-easy way to understand feedback on what the students about most: progression towards their goal. Like the guidance factor, this creates potential for persuasion depending on how the data are represented. For example, the recent attempts charts showed the last five attempts and the trajectory of the results. From the students’ point of view, they are looking for a single plot point at which they achieve their desired result. However, from the system designer’s perspective (the instructors) the behaviour being encouraged is to continually work until the goal is reached, hence why multiple data points are plotted to convey the pattern of
progress. This subtle difference demonstrates how designers can influence behaviours that benefit the user, while still persuading a related behaviour.

Interestingly, an item belonging to primary task support was also included in the list of items for visualisation. Its presence is unexpected, but can be explained by the implementation of features enabling visualisation of performance data such as the progress bars and recent attempts charts. The charts and progress bars measure study performance, and so relate directly to the functionality that allow students to complete coursework (i.e., primary task support). It is plausible that three items about aesthetics can be related to an item about primary task support in terms of how visualisation is implemented in TTM. Further, the primary task support item relates to how TTM helps students “keep up-to-date with coursework”, which validates this connection between factor and feature.

The main benefit of visualisation is that it helps address the motivation aspect of FBM. It does this by providing feedback in a manner that encourages further attempts or for attempts to be made in a correct manner the first time around—both good results for positive study behaviour. Students reported that they were better able to interpret visual data quickly. The persuasive impact of linking visual interpretation to student test performance resulted in creating the desire to reach a score of 100%. This indicates that students become more aware of how they are performing and start to think about how they study. This is similar to the concept in the stages of change model (see section 2.2.1), in which the first two stages are pre-contemplation and contemplation. Here, visualisation is being used to move students from a pre-contemplation stage to the contemplation stage.

7.3.1.3 Role of learning support in TTM

The third step in the model is learning support. Typically, an instructor is viewed as someone who is knowledgeable in the field that students are studying and has been employed by the university. Therefore, there is a level of trustworthiness associated with the instructor. The final item in learning support was concerned with TTM providing appropriate counselling to the student, which arguably can be described as the semi-regular check-ups that instructors provided, as well as the general support they offered in class. It is not clear whether this factor emerged as a direct result of instructors’ involvement, though, because the survey item refers to the TTM system and not instructors. However, instructors are actors in the system, so it is reasonable to infer that students believed TTM as an entire system was there to
support them in their learning process when things got difficult, presumably through the help offered by teaching staff. This is presumed because TTM did not offer any feature that could reasonably be considered counselling besides the instructor check-ups. This does not appear to be an issue that violates the postulate of ensuring that the people behind the system are clearly visible, as most respondents (65%) knew TTM was made by instructors.

The role of instructors in a persuasive learning system is similar to a coach or personal trainer: simply having a human presence can have a motivating effect on actions in the system. Students reported that they would have felt embarrassed with a lack of progress if the instructors came in and checked on them regularly. However, instructors should not micro-manage students because the main purpose of providing support is to remind students of their goal. The instructor can offer the bigger picture when the student becomes too focused on the guidance/feedback loop. Building in a checks-and-balances function also ensures that the PSD postulate of making sure the people behind the system are known to users is not violated. Instructors can intervene directly if they become aware of a problem developing in students' behaviour. This helps create a more ethical persuasive cycle by ensuring that students do what is required to achieve their goals and are consciously aware of why they are doing so.

7.3.1.4 Summarising the persuasive learning cycle model

The combination of the factor and thematic analysis, as well as the correlation of themes, enabled the construction of a persuasive learning cycle model that explains the contributing factors of persuasion in TTM. The model also explains the roles those factors played in students' interaction with the TTM system. The persuasive learning cycle model answers the second research question of this study: “How can persuasion in a learning system be modelled, and what factors enable it?” The model is useful in providing a general understanding of how persuasion operates in TTM.

The next step in this research is to extract high-level themes of successful persuasion strategies for learning systems to answer the third research question: “How can systems be designed to persuade students to better engage with their studies?” The following subsections explore each of the factors for themes that can be used to draw postulates to influence the design of future persuasive learning systems.
7.3.2 Guidance postulates

When considered from the point of view of just-in-time teaching and self-directed learning theory, it is logical to presume that students would seek guidance from their instructors. The goal of both of those theories is to encourage students to take ownership of their learning, and involve their instructors as consultants advising on how to proceed. However, not all students are capable of fully taking control of their learning process and require more specific advice on what they need to do. Dependant learners in particular may seek guidance that is more specific to learning activities. This sub-section discusses what students reported they sought in terms of guidance.

7.3.2.1 Provide a clear study path

Earlier in this chapter, it was suggested that TTM could be viewed as a type of coach or trainer helping students achieve their goals. When several of the participants discussed their view of TTM, they used phrases that supported this idea. For example, Participant 4 stated:

\[ I\text{ found that [TTM] was helpful because then I knew what I was looking for, because when I was tired and it was midnight, the last thing I could do was go through a 10-page reading and not even know what I was supposed to get out of it.} \]

This is a similar problem to that faced by people wanting to exercise to achieve a health goal. The avenues to achieving a goal such as weight loss or learning are complex as there are many ways to achieve expectations, which is why clients go to trainers for guidance. If the next steps are not clear, it can create confusion and result in a lack of clear direction, making it difficult to focus. It appears that students view TTM as a tool to guide them, as Participant 4 articulates: “to get given TTM at the start of [the semester], I had to decide how to use that tool and I was the one who made that decision”. While the choice of using TTM was not optional, students could choose how to use it to assist with providing direction. When they found direction, students wished to control the pace at which they proceeded through the content. Participant 2 stated:

\[ If\text{ there was any one thing about TTM I was like, “Yes, this is great”, it’s just the fact that you could self-pace yourself...it was structured: week one, week two, week three. Week one wasn’t going to lock six weeks later and be like, “You can’t enter} \]
this anymore”… [and] if you were really good at something you could quickly skip ahead.

In the above quotation, the participant specifically mentioned the breakdown of the tasks and test into weeks and how they could elect to complete them at the pace they desired. This is a reference to the tunnelling that was designed in TTM, so it appears that the guidance factor may be referring to the concept of tunnelling. However, the demands of flexibility and temporal control of the progression through the tunnelling suggests that guidance is not tunnelling by strict definition. Instead, guidance may be an alternate form of tunnelling that provides a general direction but does not enforce a specific way to achieve the goal of the process being undertaken.

One of the main features that helps provide direction in TTM is the automatic to-do list. Based on the respondents’ feedback, this feature provided the motivation that would usually come from a coach-like figure. For example, Participant 1 said: “it motivated me because...it was a bit of a, ‘Hey, you’re a few weeks behind. Maybe you should catch up.’ So if I’m in week five of class and I see [task] 2.3 on the to-do, I was like, ‘I should definitely get around to that’.” Participant 6 outlined the same problem: “I think it is a good feature, that it did motivate me, seeing that, oh, I need to complete this task which—I’m not up to date—100 per cent up to date, each week. So it did motivate me to complete those tasks before the next tutorial.” Participants 1 and 6 both described the issue of needing direction, but from the opposite side of the problem. That is, the students wanted direction initially when they began a course, but if they fell behind as the semester progressed, direction needed to be reconfigured. The week and sequence numbering of the tasks and tests using would also help student reorient themselves by clearing indicating which week they need to begin from. The automated to-do list also provided a simple yet effective trigger to remind students of what their goal was: to complete the tasks and tests.

From the above, it appears that students are seeking direction for how they should approach study. This guidance should be low-level and provide immediate steps towards reaching their end goals. This theme can be postulated as:

**Postulate 1.** Provide low-level guidance for what students need to do for successful completion of a course.
While direction is useful to students, care should be taken to not forcibly restrict how students should be allowed to progress, which leads to the next theme of the guidance category.

7.3.2.2 Allow for flexible learning strategies

The first postulate dealt with the issue of a persuasive learning system providing direction for students when they study. While this puts students at ease about what they need to do and at what pace, it does not address how students’ overall learning strategies need to be supported. That is, how students prioritise completing certain aspects of a course at different points in time. While the system should accommodate wide-ranging strategies as much as possible, it seems that students are willing to also adjust how they strategise their learning.

Observing the factor analysis items, it is interesting to note that the strongest items related more to persuasion and influence rather than the actual task completion or studying. After the first item of “TTM fits into my daily life”, the next two items were concerned with influencing and encouraging students. Some items were concerned with thinking about changing behaviour and having the system actually help students do it. The remaining items were about the actual primary task of providing a way for the student to study. This could indicate that students desire a system to encourage them because they may be subconsciously aware of an issue explaining why they do not engage with coursework. It is not that students do not have access to resources (universities typically provide adequate systems for students to use—e.g., Blackboard), but that the systems do not persuade students to overcome obstacles to working effectively. Two items that appear to be related are: “TTM makes me reconsider the way I study” and “TTM helps me change my approach to studying”. This reinforces the idea that students are aware that their study behaviour may not be optimal and that TTM could support them in changing their approach to studying. Observing this through the lens of the FBM reveals that the problem students face with completing coursework is not prominently a question of ability but of motivation.

Learning strategy has several correlations to other themes, including assessment, guidance, support, TTM and persuasiveness. TTM is a learning tool and so it is reasonable to expect that the system is correlated with explanations of students’ learning strategies. Of note, the theme of persuasiveness was independently correlated with both TTM and learning strategy, which implies that the relationship between system and student is susceptible to persuasion. The results of the survey showed that students agreed that the system had an influence on
how they approached their studying. Arguably, if students have a desire for guidance in what they need to do, there is a level of inherent acceptance of persuasion because they are relinquishing some control over the learning process in order to be told what is best to do. However, it is unclear from the data collected whether the independent link of persuasiveness actually refers to students’ desire to be persuaded or whether the system design created the effect itself. Further research would need to be conducted on this relationship. While students are willing to trust the system to influence how they study, one area they are adamant in retaining control over is their overall learning strategy.

Learning strategy was a prominent theme that arose during the interviews with students. Specifically, students prioritised the type of coursework they would complete to maximise the return on investment of their time and effort. Several students reported that they attempted to remain up to date with the course schedule for the first half of the semester. However, as time progressed and the demands of multiple courses increased, remaining up to date was not perceived as important. In particular, when multiple assessments were due, students would elect to skip the coursework and focus their attention on assignments. Participant 1 stated: “During weeks…six to eight…some of the assessments for my other courses came in, so I had to put more time into those and so [I] skipped TTM sometimes.”

Participant 4 echoed this sentiment:

*I was up to date for the first few weeks and then when the assessments started coming in I was at the point where I was able to do [the tasks], [but] I was sort of focusing more on the [assessment] instead of the task content.*

Participant 6 stated:

*Because [of] all the other assignments from other courses, [the] first couple of weeks [of semester], you tend to be motivated, then it tends to drop down because I felt like…it was just overwhelming. So I maybe tend to lose my focus on being on top of what I do in TTM.*

Lowering the priority of completing tasks and tests in TTM seems to contrast with the results described earlier that indicated students overall found tasks and tests to be very useful. One explanation could be that when students are faced with an overwhelming amount of work, procrastination is likely to occur (Milgram, Sroloff & Rosenbaum 1988) and the amount of
work completed decreases. However, as the interviews revealed, students instinctively attempted to correct this by focusing specifically on what was needed to complete the assessed coursework, thus making more efficient use of their time. For instance, Participant 2 stated:

*With the Visual Basic project, I did the first maybe six or seven weeks and then maybe the last four or five. I didn’t bother so much on exactly doing the tasks...I would just say, “Okay, how do I do a break report or a control break report?” Then instead of actually doing the thing, I would just look at how it’s done and...I would just pick and choose what’s relevant to the project.*

This is evidence of just-in-time learning as the participant clearly understood that they were limited in time to complete the course as intended. To make efficient use of their time, they selected what they were unclear about and then directly applied that to their assessment. Time management was a key factor for Participant 4, who also cherry-picked coursework to complete:

*If I feel like it will benefit me, I’m motivated to do it, but time management does come into it a lot...As I got towards the end of my course and I was juggling different things...I would just do all the questions, figure out what I learnt out of them and then do the readings because that was a more time efficient way to get the maximum value out of it.*

This is an interesting result for the system because the original intention of having bite-sized tasks was to encourage students to complete all the coursework by breaking it down into small manageable pieces. However, it appears that bite-sized tasks have had the effect of supporting just-in-time learning by giving students flexibility to pick and choose what they believe is the most useful thing they need to do at the time they believe is ideal. Observing this result through the FBM, the issue of completing tasks and tests is has more to do with ability in terms of time rather than motivation alone. As Participant 4 stated:

*There are a lot of extra activities that were optional that I didn’t do, but I wanted to do them but I just didn’t have the time. I thought that that was unfortunate, but I know that if I’d done them, it would have helped enhance my understanding. So despite being motivated to do them I actually didn’t get around to them.*
This result has implications for PSD as it appears that students are averse to having a learning system too structured in tunnelling. A system should be structured enough to provide some form of high-level direction and guidance, but not so strictly tunnelled that students are unable to be flexible with how they continue using it throughout the semester. All respondents stated that they continued using TTM until the end of semester, albeit not in the up-to-date manner they did in the beginning. This is arguably due to TTM’s flexibility, and without such flexibility students would likely not have returned to it. This finding can be summarised into the following postulate:

**Postulate 2. Accommodate students’ personal learning strategies by allowing flexibility in coursework completion.**

Another method that could be thought to encourage students to return to TTM and complete coursework is to assess the tasks and tests in order to motivate students. However, this may not be required and may even hinder TTM’s appeal to students, as the next sub-section discusses.

*7.3.2.3 Learning activities enable rehearsal and should not be assessed*

A classical approach to addressing issues with course engagement is to make the coursework assessed in some capacity. For instance, a class can be designed so that completing weekly tutorial tasks earns a percentage of the overall marks available for a course. The issue with this approach is that it removes the element of rehearsal from the learning process (and with it an opportunity to persuade through one of the PSD constructs) as every learning activity has associated risk with it. One of the behaviours identified as having a negative impact on learning performance was thinking about the consequences of failing a test (see Chapter 4). Assessing learning activities would place extra pressure on students to perform because they would have to balance the natural learning process of making mistakes and correcting them with their need to receive good grades to pass the course. Participant 5 highlighted the delicate balance between learning and assessment that students face:

*Yes, the most important thing is the learning. However, when it comes to assessments, I see an assessment as a great opportunity to practise my learning, but at the end of the day the assessment is also about getting a good grade.*
Conversely, some participants were not motivated by assessment. Participant 4 stated that assessment did not have a large impact on her reasoning for completing tasks and tests. Rather, she completed them because she “thought [she] would actually get something important out of it”, such as, presumably, a relevant skill or conceptual understanding. Participants generally preferred TTM to remain unassessed, with Participant 5 stating that he “[does not] know if you would want to link it to assessments in the end...That would defeat the purpose of [TTM]”. This “purpose” may be related to just-in-time teaching principles. Participant 4 explained: “the fact that they’re not...assessed gives you the option to do it as you need, but at the same time, because they’re not assessed, there’s not much urgency to get them done from week to week.”

The unassessed nature of the TTM tasks and tests provided flexibility in how students could approach their learning, and is presumed to be a key reason for TTM’s persuasive ability. In addition, the just-in-time learning strategy employed by students was evidently well suited to the persuasive goal of this research. The goal of a persuasive DLE is to encourage students to complete unassessed coursework to give them the foundational understanding required to perform in not only assessments but later the workplace. These results indicate that TTM was successful in encouraging this, as students overall did not entirely skip the coursework that was foreign to them. Rather, they skipped what they already knew to spend more time on what they did not know, which is a positive learning behaviour. This targeted approach to learning was raised by Participant 2 where he explains the benefits of flexibility and bite-sized tasks:

“If you want a specific feature for your assignment, you go look it up in the [task] and it’s exactly what you need ... I can take out the skill ... I need from that and the knowledge and then apply it [to assessments]”

If TTM was more self-directed, perhaps the results may have been different. Although it can be argued that students selecting individual tasks and tests to complete is evidence of self-directed learning, the students did not have the freedom to learn exactly what they wanted. They still needed to follow what was prescribed, and were guided on what to do next. Students evidently wanted control over how their learning process occurred, particularly in being able to rehearse their skills for assessment. Thus, the third postulate is:
Postulate 3. Students prefer learning activities to allow rehearsal without direct assessment.

For a system to be holistically persuasive, support needs to occur in all components, which is explored in the following theme.

7.3.2.4 Support the primary task throughout the system

One component of the TTM system that was not as successful at encouraging students to complete coursework was the Study Helper mobile app. When considering students’ reception of Study Helper several issues need to be discussed to provide context for the results. First, the app suffered from various technical issues throughout the semester. Based on observation and informal student feedback given to the researcher during the trial, students reported issues with the to-do list function inside the app not synchronising with the web portion of TTM. The web-based component would accurately track tasks and test completion but Study Helper would not show any completion at all. While this was resolved several weeks into the semester, the perception of reliability and trust in the minds of students would have been damaged and doubt cast on whether the mobile app was accurate. Another issue reported by students was that weekly or before and after class notifications were not always received. This issue was not identified until very late in the semester and so a solution was not available for long enough for students to experience the intended use of notifications. Notifications were one of the main justifications for creating Study Helper, so this would have severely hampered the usefulness of the app for students.

Another aspect to consider when assessing the results is the major point of difference between the features of the web-based TTM and Study Helper, as detailed in Chapter 6. Study Helper features the automatic to-do list, recent history charts and performance tracking of the web-based TTM. It also includes extra features such as notifications, a message centre, and a quick view of students’ completion status in a course, but does not include tasks and tests; these are only available on the web-based TTM. Lack of tasks and tests could have potentially reduced the perceived usefulness of the app since it does not directly provide support for what students perceive as the primary task. The unfavourable results for Study Helper specifically but not for the TTM system overall indicate that respondents may have viewed Study Helper as a standalone component and not as part of the system overall. Study Helper was intended to be considered an add-on to TTM, indirectly supporting the primary
task by extension but focusing more on enhancing dialogue support through the use of reminders and notifications. However, the connection between the two components of the overall system failed to be conveyed to students. The main strength of Study Helper is tracking progress and encouraging continual effort in completing coursework, but from students’ perspective, tracking progress is not a goal but a means to achieve it. Their goal is the acquisition of knowledge and skills to apply to their assessed work, which will allow them to graduate. Thus, it appears that there is a lack of cohesion between the web and mobile components of the TTM system. In general, interviewees confirmed this notion of Study Helper being a separate tool, but thought that the concept of having an app might be useful if it supported their primary task in some way.

The coded interview data related to TTM were shown to have correlations with the factors of guidance, visualisation and learning support. By coding the system as TTM (web) and Study Helper (mobile app), it was found that both TTM and Study Helper were linked to guidance. The theme of Study Helper was not linked to any other theme, unlike the TTM theme. Nevertheless, the correlation of the themes of Study Helper and guidance indicates potential for a mobile app to serve that specific purpose. That is, the primary task support that was identified as lacking may be resolved by focusing on how the app can provide guidance. The main persuasive feature of the mobile app that the web-based system did not have was push notifications to implement reminders. Study Helper could have been more effective if it had aided in guiding students in what they needed to do, rather than replicating the features of TTM.

The survey results indicate that respondents used Study Helper roughly one to two times per week. Usage was higher earlier in the semester and then tailed off in later weeks. Participant 4 explained how her use began with “[trying] to use it once a week, [but then] it became more like once a month after a while”. This could be due to the technical difficulties students experienced with the app, as Participant 4 described the app as “buggy and it didn’t work”. Another reason for Study Helper’s lack of adoption by students could be that students did not see the app as part of the overall system, particularly because the app does not allow them to perform tasks and tests, which is essentially the primary task support of the overall system. The push notifications enabled by the app were not useful because students were only being triggered to complete coursework and were not able to action the request directly. Participant 4 made this shortcoming clear: “Study Helper: you’re able to see what tasks you’ve done,
which tasks you haven’t done but you can’t do much more beyond that. So you can’t say open up the task or do the test”.

Participant 6 believed that even if the app allowed for task and test completion, she still would not have found it useful because being prompted to study was a temporal issue for her:

I wouldn’t use the app, pretty much, because I would spend my time on TTM during my tutorials. I didn’t feel the need to be on my app because I would already know...what I completed and what I haven’t completed or what I need to catch up on. So, to me, the app...wasn’t as useful as I would have liked it to be.

Triggering students to engage with coursework outside of the scheduled class times was one of the main goals of having push notifications in Study Helper. However, it is evident that not all students would be responsive to this kind of persuasive mechanism. Sending push notifications with the intended effect of getting students to immediately engage with the content goes against the just-in-time learning principles participants employed. Students wanted to control when they learned, which for some was only during the tutorial. Outside of the tutorial, they did not want to be bothered with messages, or only wanted messages at times when they were willing to respond. For instance, Participant 3 wanted reminders to be sent “in the time that I want to receive it like maybe on Saturday morning. I have nothing to do [so] I want to study”. It appears that the automated to-do list and various completion graphs were adequate in guiding students on what they needed to do as Study Helper was not able to fully support this.

The lack of primary task support in the app severely undermined its persuasive potential. Participant 5 stated that “I didn’t understand why there was an app and TTM already does a decent job at telling you what you haven’t done and what you have done.” Participant 6 noted that being explicitly instructed to do more coursework made Study Helper feel like “it was an alarm clock that just reminded you that you need to complete [things]”.

Suggestions from participants on how to improve Study Helper were directly related to primary task support. For example, Participant 4 suggested that using it to complete tests “would be a good idea if you’re on your way to a lecture and you’re looking for something to refresh [your memory] you could just sit down and do the test on your phone”. Participant 3 was more interested in Study Helper acting as an administrative support for learning. He suggested a future version of the app have “just an exam timetable, class timetable and your
assignment marks”. These aspects of the learning process are already designated to Blackboard, but it appears that students may be open to a crossover between their learning support systems (TTM) and administrative support system (Blackboard) in the form of a general purpose mobile app. This may bridge the gap between the two types of systems and could provide a solution to the problem of Study Helper not featuring primary task support. For example, students indicated that they wanted support for their high-level study concerns: general knowledge rehearsal, and class times and locations.

Regardless of what the specific primary task may be, it is clear from this theme that a particularly strong postulate for learning systems is:

Postulate 4. Each component of a persuasive learning system should support the primary task.

7.3.3 Visualisation postulates

TTM makes heavy use of visual representation of data throughout the system, including the recent test attempts charts, the progress bars indicating overall completion as well as the bar charts to monitor performance at various levels of detail. These charts and graphs were designed to be persuasive by visually communicating important information that was expected to trigger behaviours to occur. For instance, the recent attempts chart only showing one plot point with a score of 20 is intended to trigger students to continue attempting the tests capitalises on intrinsic motivation the highest possible score of 100. The factor analysis found that respondents felt strongly about the aesthetics of TTM, which was built with professional tools to give it a user-friendly interface. While aesthetics are not necessarily the same as visual representation of data, the inclusion of the factor item related to keeping up to date with coursework implies that the clean and easy to interpret interface allowed effective visual feedback to be conveyed to students. Displaying feedback in a way that is meaningful and useful to students is the key driver of the following visualisation postulates.

7.3.3.1 Represent performance data visually

Several participants confirmed that the charts in TTM helped prompt them to re-engage with the coursework and remind them of what they needed to do. Participant 2 explained how he used TTM: “I used to just look at going to each week and look at the charts, and if I didn’t have a [data point on the graph] there I’d be like, ‘I haven’t done that yet’”. In other words,
Participant 2 could identify what he needed to do immediately. This was also true for Participant 7, who found the visual representation to be beneficial because “when [progress is presented] as a graph…it’s quite easy to interpret”. Fast and easy interpretation of somewhat complex data is one of the strengths of visualisation. In the case of TTM and study behaviour, there are multiple levels of progression that need monitoring. Each week there are several tasks and tests and there are many weeks’ material to complete. Participant 7 further explained why visually representing what has already been completed is useful: “the visual aid is helpful because sometimes you just don’t know where you stand in a subject”. If a trigger is simple yet effective like the TTM visualisation, it can provide great potential for persuasion to occur because it conforms with the postulates of PSD that outlines how systems should be unobtrusive but still able to encourage certain actions to be performed.

Beyond acting as a trigger for behaviour, the larger persuasive potential of visualisation is to motivate students to study continually throughout semester. As described in Chapter 5: 6, the charts and graphs in TTM are designed to convey subtle information; for example, a positively skewed graph indicates that a student’s performance is positive. This design was intended for students such as Participant 1, who mentioned how he is “still quite a visual person and it does have a bit of an impact”. Visualisation also helps students who study at different times, which in the case of Participant 4 was “working around work and things like that, so you’re often sitting really late at night or random times, so to have something that’s a visual as opposed to just numeric makes such a difference”. Participant 5 expressed how the charts and graphs motivated them, though they were not sure why they were not performing optimally: “I don’t know what I was doing wrong, but it did help me—motivate me—to get higher marks throughout the TTM tasks that were given”. Thus, students were very responsive to the visual representation of their performance data. Placing the charts at the top of the page most accessed by students may have prompted students to think about their overall performance. This leads to the fifth postulate:

Postulate 5. Provide visual feedback about progress near the point of access of the primary task.

The following theme explores using visualisation to create longer-term motivation that is more persuasive.
A correlation consistent in both the interview analysis and survey data is the link between motivation and visualisation. The relationship between those two themes is evident in the use of charts, graphs and progress bars throughout the system. The feedback provided to students through the use of visualisation can also explain why the learning strategy theme was related to visualisation. Motivation and learning strategy were also correlated, forming a triangular relationship between the three themes. This finding indicates that there is a loop that occurs between students developing a strategy to learn, being given visual feedback on their performance and then this feedback enhancing their motivation to continue learning. This describes a traditional learning feedback loop (Butler & Winne 1995), while the addition of motivation provides an opportunity for persuasive design to be used. However, the theme of persuasiveness was not strongly correlated with motivation in the coded data. This suggests that persuasiveness as a construct is too abstract to have a direct impact on motivation. Instead, it is the implementation of system qualities as proxies for persuasive principles that carry out the perceived persuasion of the user.

Although the tests in TTM were unassessed, the visualisation of performance data had an effect akin to assessments in how seriously students took their attempts. For example, Participant 2 explained that the plotting of every attempt on the chart motivated him to complete tests properly so as not to spoil the positive view of the chart: “the way that it shows the scaling — your attempts — that was good motivation to get it right the first time”. This was an unintended side effect of graphing performance, as it was expected that students would take advantage of the unlimited number of attempts to eventually correct the charts by getting all the answers correct. However, Participant 2 was intrinsically concerned with not producing a negative-looking chart, even though such data are not shared with anyone else. While this attitude would likely not apply to the majority of students since it is an intrinsically linked motivation for this student, there may be future opportunity to leverage such intrinsic pressure or motivation. It could be used to ensure that students are not selecting every possible answer to eventually find the correct one and artificially inflate their results, but are attempting to complete the tests properly.

The importance of enhancing motivation to complete coursework correctly becomes greater as a semester progresses. This was evident from Participant 4’s experience:
At the start, it wouldn’t have been motivating much, but especially as you get to the second half when you need the motivation because you’re almost done and that’s when all the harder assignments are. It would have been really good because it’s like there’s not much more to go, so I think it would have been motivating to see [the chart plot points] at the top.

The visualisation of performance data may be motivating because this mechanism delivers clear and actionable feedback to the student. While, the tests themselves provide written feedback about students’ knowledge of the course material, the performance charts provide tailored feedback for how they are progressing at a higher level. Participant 2 supported this: “I thought it was cool that you could actually see it and the system was giving you feedback like that”. Participant 4 explained how visual performance feedback played a role in encouraging students to want to do better the first time: “using [recent performance history charts] instead of the [written] feedback … was [to] deter me from just guessing and then sticking to my guess once I’d gotten it right”.

It could be argued that the visualisation of performance data takes advantage of the conflict students face between time pressures and their wish to succeed academically. Visualisation reminds students of their goal of performing well but also targets their desire to get work done quickly. As a result, students focus on the task at hand more closely so they can complete it correctly before moving on. In this way, they are motivated to engage with the coursework in a meaningful way.

It is evident from the data collected that TTM is perceived to be a well-designed and visually pleasing system. Study participants conveyed that performance charts were that most persuasive form of visualisation because it was tied to their motivation. In addition, while the visualisation factor had strong results for the aesthetics of the system, also included was the item “TTM helps me keep up to date with coursework”. Participants confirmed that the visual aspects of TTM were among the main drivers motivating students to continually engage with coursework over the entire semester. Without this feature, the persuasive potential of TTM would have been severely hampered. Hence, the second visualisation postulate can be summarised as:

**Postulate 6. Visualising performance trends can provide enduring motivation for students as a course progresses.**
7.3.4 Learning support postulate

Only one postulate has been crafted for learning support, but it highlights the important role instructors play in the persuasive learning cycle model. Although a persuasive system implies that the technology itself will persuade, instructors are crucial in ensuring that students are supported in their learning. Instructors play different roles at various levels of the staged self-directed learning model. When students see the instructor as a consultant, instructors can remind students of their long-term goals. More dependant learners require specific support to overcome their issues, and so instructors can use the data gathered in the system to help address specific needs of individuals.

7.3.4.1 Tailor support to individuals

Observing the three factors at a high level, the relationships between the factors and the roles of the actors in the system can be extrapolated. One relationship of particular interest is how the system and instructors work together to provide students with a learning platform designed to encourage higher levels of academic performance. This highlights how TTM solves the problem of instructors being diverted from their core role of teaching and having their time taken up with addressing specific low-level issues students may be having. With TTM acting as a coach-like figure and the instructor in a supporting role, each can be used for their strengths.

When extracted from the survey, the meaning behind the learning support factor was not as clear as other factors, although it did appear to be related to the instructor's role in the system. This is due to reasons such as TTM being trustworthy, showing expertise and providing appropriate counselling. Trustworthiness and expertise can arguably be applied to the content of the course materials because they are created by academics and the system is authentic. However, the inclusion of counselling indicates that the learning support factor is human-related because TTM does not offer counselling, not even unintentionally through design or interaction. Throughout the semester under study, instructors were advised to conduct check-up consultations and informally ask how students are progressing. Participant 2 explained how he:

"felt a lot more pressured to do the tests when—at the very start of the semester, I think it was—[the instructor] would come around and be like, “Okay, so where are you at with TTM?” and they would get you to pull up your [account]."
Although the participant felt “pressured”, this may be a response to being reminded of why he is completing tasks and tests, which is linked back to assessment. Participant 6 made this connection:

[The instructor] would remind us...every couple of weeks that whatever you do in TTM...we could use it as exam revision. I guess that was part of my motivation to complete all my tasks in TTM.

Reminding students of the bigger picture of what they are doing day-to-day is an example of showing expertise, and coming from an instructor, it is trustworthy advice. Collectively, this can be considered as counselling. It was not perceived to be coercion, as Participant 2 went on to say that “[instructors] weren’t going to bother me about it. They weren’t going to come over and say, show me and shake their heads when I was six weeks behind”. Students may have wanted to avoid being embarrassed when they were behind, but they understood that it was only to encourage them to keep working. To quote Participant 2 again: “I feel like if they had have [checked in regularly], that would have been good motivation for me to stay up to date”.

One aspect of the system that was intended to be an extension of the instructor was the implementation of study tips and motivational messages. The tips were crafted from the results of the behavioural analysis in phase 1, and were written in a way that would sound like advice from an instructor. For instance, one of the tips suggested that “studying the easy parts is a great confidence booster, but studying the hard parts is what will improve your grades”. Some students thought these were useful, with Participant 1 stating: “they’re very positive and helpful...they could have an impact on my actions”. However, the tips and messages may have been too generic to be useful. Participant 2 would have preferred more specific messaging:

If there was a hint specific to that task that I was trying to complete that was like, “Hey, if you’re having trouble with this task, you could do this”, that would be really useful. But I think general [tips] like, “Nuts are a good brain food”, those kinds of [general purpose] tips I just ignore.

This further underscores the important role of tailoring, which is part of the PSD model that can be utilised through the way the instructor supports students. Specific advice and motivational messages may be better suited coming from instructors who have developed
rapport with their students through informal discussions that take place in class. This leads to the final postulate:

**Postulate 7. Instructors should monitor student progress in the system and provide tailored counselling to specific students.**

Table 23 summarises all seven postulates that will help system designers build more persuasive learning platforms that will improve the likelihood of students engaging with coursework.

*Table 23: Summary of persuasive learning system postulates*

<table>
<thead>
<tr>
<th>Factor</th>
<th>Postulate (short)</th>
<th>Postulate (full)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guidance</td>
<td>1. Provide a clear study path.</td>
<td>Provide low-level guidance for what students need to do for successful completion of a course.</td>
</tr>
<tr>
<td></td>
<td>3. Learning activities enable rehearsal and should not be assessed.</td>
<td>Students prefer learning activities to allow rehearsal without direct assessment.</td>
</tr>
<tr>
<td></td>
<td>4. Support the primary task throughout the system.</td>
<td>Each component of a persuasive learning system should support the primary task.</td>
</tr>
<tr>
<td>Visualisation</td>
<td>5. Represent performance data visually.</td>
<td>Provide visual feedback about progress near the point of access of the primary task.</td>
</tr>
<tr>
<td></td>
<td>6. Visual feedback endures.</td>
<td>Visualising performance trends can provide enduring motivation for students as a course progresses.</td>
</tr>
<tr>
<td>Learning Support</td>
<td>7. Tailor support to individuals.</td>
<td>Instructors should monitor student progress in the system and provide tailored counselling to specific students.</td>
</tr>
</tbody>
</table>

**7.4 Summary**

This chapter presented and discussed the results of several analyses conducted using mixed methods of quantitative and qualitative analysis of both survey and interview data. Overall, students did not appear to be concerned with having full control of their learning process and being self-directed, in contrast to what is traditionally assumed. Rather, students wanted control over when and where their learning takes place in a just-in-time approach. This was
first found in the descriptive statistics analysis of the survey data. Students regularly used the web-based component of the system and considered it very useful, particularly because of the tasks and tests it featured. Most respondents agreed that they would like to see TTM used in other courses they undertake. The Study Helper mobile app did not receive the same level of praise, with most respondents stating that they installed the app, only to discontinue using it as the semester progressed. This was determined to be a result of various technical difficulties, such as malfunctioning to-do lists, as well the app lacking the key feature of the web version of TTM of enabling students to perform tasks and undertake tests.

The survey data were then analysed using principal component analysis, which resulted in the extraction of three factors: guidance, visualisation and learning support. The guidance factor included a mixture of items related to primary task support and perceived persuasiveness. TTM was viewed as a system that provides direction in what students need to do to achieve their learning goals. The system gives feedback on how students are progressing through the visualisation factor. Instructors were found to play an important role in maintaining the intended focus in the system by checking on students every few weeks. The thematic analysis identified a number of themes, including the three factors mentioned above. A thematic correlation analysis was performed on the coded interview data, which revealed a number of connections suggesting a relationship between the three factors. This was represented as a model that outlines the persuasive learning cycle that occurs in TTM and can be generalised for designing persuasive DLE. Through synthesis of the factor and thematic analyses, and the persuasive learning cycle model, seven postulates were constructed covering three factors: guidance, visualisation and learning support (see Table 23). The model and postulates are significant contributions to the persuasive design philosophy presented in this research.
Chapter 8: Conclusion

8.1 Overview

This chapter summarises the research that was carried out across three phases—behavioural analysis, system selection and persuasive design—and the analyses of perceived persuasion in the TTM next-generation DLE. Key findings are presented, followed by an explanation of the significance of the research and its implications for research and practice. The limitations of the thesis and possibilities for future research are also discussed.

8.2 Summary of Research and Key Findings

Universities are facing a changing climate of student demographics, with greater numbers of students of varying academic experience and ability entering programs. These changes have strained the capabilities of learning environments to motivate students and engage them in their studies. Simultaneously, higher percentages of students are taking on responsibilities outside of academia, such as part-time and full-time employment, reducing the amount of time they can afford to spend studying. With limited time available and DLE not actively encouraging students to engage with their studies, the student experience in these learning environments will likely continue to diminish. This may lead to poorer learning outcomes because students will not be able to fully invest in their learning process. The aim of this thesis is to develop a systematic design approach in the form of a design philosophy that can be used to enhance DLE by catering to the changing needs of modern students without sacrificing the integrity of learning activities. Three research questions were formulated to achieve the aim; each of these questions is addressed in the following sub-sections.

8.2.1 Research question 1: What impact does existing student learning behaviours and strategies have on academic performance?

Before a system for persuading students could be built, the current behavioural trends needed to be assessed to uncover positive behaviours that could be further enhanced through persuasive design. Current students and alumni were surveyed using a modified MSLQ on their experience as students. In addition to the standard MSLQ study behaviour and motivation questions, two additional questions were included. One enquired about the respondents’ self-perceived level of academic performance, and the other used results-based
criteria to measure the impact particular behaviours had in learning outcomes. The data were analysed using ALM and two models were constructed using MLR based on the two additional question items mentioned previously. A key finding from the models was that current students were more concerned with behaviours that were likely to lead to short-term, assessment-focused benefits. In contrast, alumni reported behaviours that were more favourable for long-term learning. The behaviours reported by current students were found to be at the lower order of Bloom’s taxonomy for learning, while alumni rated higher. This indicated that current students were primarily concerned with time management, and so subsequent questions explored this further in the context of how to design a persuasive system.

8.2.2 Research question 2: How can persuasion in a learning system be modelled, and what factors enable it?

The second research question sought to understand which factors led students to perceive a system to be persuasive in encouraging them to engage with coursework. In order to collect data to identify the factors, a learning system needed to be selected and enhanced with persuasive features. That system would then need to be used by students in class. Employing the PSD framework, two existing DLE, TTM and Blackboard, were assessed for inherent persuasiveness by an expert panel that included the researcher. TTM was found to be more likely overall to be perceived as persuasive due to the system’s focus on supporting the student learning process directly, as opposed to Blackboard’s strength as an administrative learning tool. TTM was then enhanced by implementing persuasive system qualities that also aligned with the behaviours identified from the first research question. A key finding from this phase of the research was that both systems contained similar numbers of inherent persuasive system qualities, yet the expert panel judged TTM the more suitable candidate system due to its overall design. A secondary finding was that both systems had low levels of dialogue and social support, while having strong primary task and credibility support. Enhancing dialogue support, therefore, was a main reason for implementing the mobile app companion to TTM, Study Helper.

Students used TTM for a semester and at the semester’s conclusion were surveyed about their experience of using the system. Students were also invited to participate in interviews to provide this thesis with a deeper understanding of the persuasive effect TTM had on them. The survey instrument was adapted from an existing questionnaire that measured the
persuasiveness of a health system. The results of the survey indicated that TTM was viewed favourably by students, who self-reported that it had a persuasive impact on their learning process, particularly in encouraging changes to their approach to studying and instilling confidence. The data collected were used to perform a factor analysis, which resulted in three factors being extracted: guidance, visualisation and learning support. Interviews were then conducted to further reveal the context of the factors, and the information was used to model the relationships between the factors. Key findings from this process included:

- The main barrier to students consistently engaging with coursework is time management. Persuasive design elements should be more focused on improving motivation to study rather than assisting with the ability to do so.

- With limited time due to external commitments such as employment, students seek guidance on what they need to do in the short term. Students prefer to complete work in a just-in-time manner, concentrating on the skills and knowledge they need at that particular time.

- Providing guidance and representing performance data visually has a significant positive impact on student motivation to continue using TTM, and can be described as a persuasive learning cycle.

- Students view the role of the instructor in the system as someone who is there to help when required, but students do not desire micro-management of the learning process. The instructor can also ensure the persuasive cycle continues to function by addressing issues as they arise.

The persuasive learning cycle model produced in this phase of the study was a significant finding and contribution. The model provided a foundation from which higher-level postulates for designing a complete persuasive DLE could be identified. Identifying such postulates is part of the aim of the final research question.

8.2.3 Research question 3: How can systems be designed to persuade students to better engage with their studies?

Answering this final research question required the identification of postulates for designing persuasive learning systems. This was achieved by formulating the findings from the
persuasive model and summarising them into principles that can be followed by other system designers. Seven postulates were identified as a result of the mixed-methods data analysis conducted on the survey and interview data collected from students. The persuasive learning model provided a high-level understanding of how persuasion functioned in TTM; however, a thematic analysis and thematic correlation of the interview data provided more insights into how students perceived the persuasion, as well as why particular implementations of the persuasive features were or were not successful. The seven postulates derived from each of the three factors of the persuasive learning cycle model were:

**Guidance**

1. Provide low-level guidance for what students need to do for successful completion of a course.

2. Accommodate students’ personal learning strategies by allowing flexibility in coursework completion.

3. Students prefer learning activities to allow rehearsal without direct assessment.

4. Each component of a persuasive learning system should support the primary task.

**Visualisation**

5. Provide visual feedback about progress near the point of access of the primary task.

6. Visualising performance trends can provide enduring motivation for students as a course progresses.

**Learning Support**

7. Instructors should monitor student progress in the system and provide tailored counselling to specific students.

All research question being answered, the overall aim of the thesis can now be addressed, which is to establish a systematic approach to designing persuasive systems in the form of a design philosophy, intended to guide the development of DLE for students to better engage with coursework. The finding is that persuasive learning systems should be built in accordance with the seven postulates and implementing the factors identified in the model, to
underpin the successful study behaviours and strategies of students. This will likely enable the system to engage and motivate students to improve their learning outcomes.

8.3 Research Significance and Contribution

For effective learning to take place, students need to be engaged with their study and instructors need to provide a learning environment that is motivating and supportive of the needs of students. Rapid technological advancement and a changing cohort of students has created a disconnect between this foundational relationship in higher education, and so calls for next-generation DLE emerged. To ensure interactivity is maintained in the learning system, students need encouragement or rather, they need to be persuaded to continually work. The results of this research indicate that time management plays a large part in why students disengage. Therefore, the persuasive learning loop uncovered in the analyses of data is significant for understanding how DLE need to function. Encouraging students to engage with coursework is desirable for instructors wanting to educate their students and for students wanting to improve the quality of their learning. Traditional learning systems have not been specifically designed to influence student study behaviour, often relying on the instructor to perform this duty. Particularly in a university setting with large groups of students, this is not feasible. To alleviate this problem, persuasive techniques were applied to a new digital learning system, which was successfully implemented and evaluated in this research.

This thesis has made a number of significant contributions. First, behaviours were uncovered that had the largest impact on learning performance in terms of self-perceived and result-based performance. This informed the design of the persuasive features of the system, but the results can also be applied to any scenario involved with altering the learning environment. Second, the results of the student experience of using the system have implications for future development of persuasive learning systems by uncovering the success factors and modelling how the system functioned. This will help inform the design of future systems and improve the likelihood of successfully encouraging students to alter their behaviour. Third, the Study Helper component results were not as positive as the web-based TTM system results. This finding contributes knowledge to the field of PSD by highlighting the importance of providing primary task support in every component of a learning system since it was missing from the app. This is significant because it improves the understanding of how the PSD should be applied in a real-world system. Fourth, the formulated postulates can provide direction for future development of persuasive learning systems. Learning systems in
particular can now be evaluated against these postulates to test whether the systems are likely to persuade students in their learning.

Collectively, the behavioural analysis, persuasive learning model and postulates contribute an education-specific persuasive design framework that will be valuable for both educational system builders and educators. This has a number of implications that are explored in the following section.

8.4 Implications for Pedagogy

The persuasive system in this research was evaluated for the purpose of addressing issues with modern learning environments and engaging students. As such, the results are expected to have implications for pedagogy, particularly the phase 1 findings relating to successful learning behaviours and the phase 3 findings relating to system design.

8.4.1 Student learning behaviour

The phase 1 research revealed differences in student behaviours between self-perceived and results-based academic performance models. Very few individual behaviours or motivation strategies were common to both, indicating that study behaviour is very complex. Therefore, educators would be more successful if they encouraged general positive study behaviours rather than focusing in on any one particular low-level behaviour. This thesis selected a general behaviour with the goal being to simply engage students with coursework. The strong results of this research suggest that this is an advisable strategy.

The behavioural models for current students showed that their concern was primarily for the short-term rewards of their study efforts. Behaviours and motivation strategies revolved around actions such as immediately clarifying notes. For instance, one behaviour was: “If I get confused taking notes in class, I make sure I sort it out afterwards”. Such behaviours can have great implications for educators who seek to ensure that students remain engaged with the course. If instructors do not provide easy-to-access and regular opportunities for students to “sort it out afterwards”, then there is a chance that some students may disengage and likely suffer in terms of academic performance. Understanding that students who are currently in the process of studying are primarily concerned with their immediate focus of completing the course implies that educators need to build courses with this as the baseline. Following this, they can encourage students to start thinking about their broader behaviours and strategies.
The alumni group in the research were able to see the “bigger picture” of their study behaviours and strategies. It can be argued that alumni models for measuring impact on academic performance represent “successful” students (since alumni have obtained their degree). Therefore, educators could use alumni models to set goals for their current students. The alumni study behaviours identified are not necessarily better than others, but the findings do reveal a relationship between undertaking certain behaviours and strategies and successful completion of a degree. By understanding the relationships between behaviours and different areas of performance, educators will be better able to determine how to develop their curriculum to empower students to develop a wide range of study skills. Coupled with a persuasive system to influence these behaviours in students, this knowledge may lead to improvements in overall student learning outcomes.

8.4.2 Time management and micro-learning

Time management was a concern for students, particularly managing study and work commitments simultaneously. Traditionally, higher education institutions recommend that students allocate time to studying equivalent to what would constitute full-time employment. While allocating most of students’ available time to studying would benefit their learning, increasing numbers of students require income to support their studies and so are more likely to prioritise their time for paid work. In the long term, prioritising work over development of critical skills is not ideal because it reduces the effectiveness of studying. Instead of resisting this change in cohort attitudes, it is advisable that institutions adjust to cater for it and utilise persuasive systems to continue to educate students with the skills they require.

One finding of this research is that students prefer bite-sized tasks and tests where they could focus their effort on the skills they needed and do so around their work schedules. This has an implication for educators designing courses in that content should be made to be consumed in smaller pieces. Although this may be difficult to achieve for every type of course content, it is advisable to use this approach as much as possible in order to improve the likelihood of engaging students with the material. The size and delivery method of course content is one of few aspects that institutions and educators have direct control over (students are in control of other aspects such as attendance and participation). Universities cannot force students to complete coursework, but they can control how it is delivered, and adjustments to delivery as suggested are likely to result in improved student experience satisfaction. Improving this metric may in turn lead to more enrolments from students seeking a university experience
that is personalised and caters to their needs. Entirely new courses do not need to be devised to create bite-sized tasks and tests. Several courses in this research used existing material that was available in long-form tutorial tasks and broke those down into smaller pieces. While some courses were newly constructed using micro-learning principles, students felt TTM was strongly persuasive in either case.

Another implication for pedagogy relates to the role teaching staff have in a persuasive learning system. The research revealed that instructors were the crucial component of the learning support factor. While the system is adept at handling higher-level guidance through learning activities, instructors are better suited to supporting the individual needs of students who require assistance. As this thesis has argued, instructors can leverage persuasive systems to handle the general tasks of teaching and take on a role more akin to coaching and support. This means that instructors can better use their time to address why students are struggling to understand course material, rather than assisting with the more operational aspects of learning. This concept is an extension of historical practices for assessments such as multiple-choice tests. Computerising these tests allows instructors to focus on broader themes in the course material. Persuasive learning systems could provide the same benefits, albeit at a higher level of learning abstraction.

8.5 Implications for Research

This thesis has a number of implications for research. First, the strong results for system usage and individual persuasive survey items such as “TTM has an influence on me”, “TTM encourages me” and “TTM helps me change the way I study” indicate that the PSD principles can be applied successfully to a DLE, and are effective. Further research could explore how these persuasive principles could be used to enhance students’ learning capabilities by encouraging them to complete unassessed coursework and perform better on assessments.

The factor analysis also helped to identify factors that contribute to a learning environment being persuasive. A key finding from the persuasive learning cycle model was that it appears successful persuasive systems may require the system and the instructor to play very distinct roles in the system. A system is better suited to supporting students by motivating and encouraging progression in studies, while the instructor is better suited to mentor students and provide support for particular problems. Future research could investigate whether these roles apply to and are helpful in persuading other types of behaviours. The identification of these
roles also has implications for research on massive open online courses. These courses are delivered via the internet to large numbers of students across many countries and enrolment can be free. However, they suffer from high levels of student attrition and struggle with student engagement (Gütl et al. 2014). Understanding the roles the actors play in those systems and comparing them to the results of this thesis may be beneficial in creating more engaging and motivating massive open online courses for large scale teaching and learning.

8.6 Limitations

This research involved numerous statistical analyses and several instances of data collection, which means some limitations were encountered. At a high level, the research is exploratory in nature and so the results and models constructed are not generalisable in their current form. More data will need to be collected across various study disciplines to validate the models. Lack of generalisability was in part due to the available population of students using TTM. Only students from several business IT and social science courses were actively using the system at the time of this research. This placed a restriction on the total number of possible samples that could feasibly be collected. It also restricted the types of students that could participate in the study to IT and social sciences, and so the findings were specific to the context of those courses. Further limitations are described in the following sub-sections.

8.6.1 Sample bias in behavioural analysis models

During phase 1 of the data collection and analysis, it was evident that the types of students who responded to the survey were typically “good” students. They were academically high performing and generally exhibited positive study behaviours, although this was self-reported. Receiving responses from mostly good students did not hinder the identification of the key study behaviours that enhance performance since encouraging students to study optimally is the long-term goal of this research. However, it did mean that obtaining insights into the behaviours that inhibit good study behaviours was not possible. Potential behavioural barriers that inhibit students from performing optimally had to be deduced from the “good” student data collected.

8.6.2 Persuasive learning cycle model

Although a number of significant findings were extracted from the qualitative and quantitative data, there were a number of limitations encountered in the process of analysing
the data. As mentioned, the persuasive learning cycle model was constructed from a small yet significant sample of the population of students using TTM. The smaller sample size restricted the ability to perform a factor analysis that included all of the available survey items, which means that there are potentially more factors involved in a learning system being persuasive to students. Another limitation of the model is that the relationships between students, instructors and the factors were extrapolated from the thematic analysis and thematic correlation. Those relationships were not directly tested as hypotheses and so further work is required to validate them, which may uncover more detail on how they operate.

8.7 Future Work

The results of this research have created a number of potential avenues for further exploration, which are detailed below.

8.7.1 Influencing workplace behaviour

A longer-term study could involve investigating whether acquiring the study behaviours identified in this research have an impact on workplace behaviours and productivity. The logical progression for a student is to graduate from a degree and find employment, and so it may be useful to investigate whether one’s learning behaviour as a student correlates with workplace learning behaviour. Such research could be conducted through the lens of lifelong learning to analyse whether establishing good study behaviours translates to the workplace, and the impact this has on productivity. This would be of particular interest to both educators and employers.

8.7.2 Validating and generalising the persuasive learning cycle model

One of the major contributions of this exploratory research is the identification of the persuasive success factors, the subsequent modelling of how persuasion operates in a learning system such as TTM and the postulates for its design. The models and postulates presented in this research were specific to business IT and social science students. It would be advisable to conduct the same research on students from a wider variety of disciplines. In particular, courses with materials that are intended to be learnt sequentially or are modular in nature (making them similar to programming) would be of particular interest to test the models and postulates against. This would be the reasonable next step in furthering the work of this thesis. If the persuasive learning cycle model is validated in these cases, then other work may
explore the role of these persuasive factors in learning systems that are more complex, such as courses that are based on long-form essay writing or creative arts. Arguably, even these courses could be decomposed into bite-sized pieces for learning of fundamental skills.

While the model and postulates as they currently stand contribute to new knowledge of how persuasion operates in a DLE, further work can be carried out to directly test the level of impact these factors have on academic performance. Future research could construct a new persuasive learning system following the postulates identified in this thesis, and incorporating the factors of guidance, visualisation and learning support. Students could use a system developed under these conditions and then be surveyed/interviewed on both their experience of using the system and the impact it had on their academic performance. Phase 1 of this thesis investigated study behaviour, so there is also potential to measure the impact that a persuasive system can have on study behaviour.

Generalising the persuasive learning system model would be beneficial in the long term. Generalising is justified as it is reasonable to presume that the factors identified in this thesis could be found in persuasive systems in general. For example, a persuasive system in the workplace could be used to train new recruits by providing guidance on what is required in the job. The system could then motivate the employee to continue by visually showing progress towards competency. Managers could play a similar role to instructors and offer more targeted support and counselling when required. This is only one example, and there are likely to be many others that could be beneficial to employers and to many other disciplines and contexts.

8.7.3 Habit-forming persuasive systems

The scope of this thesis was limited to evaluating and understanding how persuasion can function in a DLE. Given the encouraging results of the persuasive learning system model, future work can continue with the next two phases of achieving the long-term goal of developing a habit-forming persuasive learning system. Figure 54 outlines the long-term road map of PSD for learning.
The next research project that could be developed as an extension of this research could develop or augment a DLE system using the model and postulates to guide the design and implementation, as well as the original PSD framework. This system could be trialled with students, and data on how students behave while using the system logged and used to measure the actual impact a persuasive learning system has on day-to-day study behaviour. Aspects such as time of day that students interact with the system, number of engagements per day and many other behavioural traits could be collected. These could then be used to identify the specific influence that persuasive features have on students, and to identify sub-optimal behaviour and provide recommendations to students on how they could improve.

More social features could be integrated, which was an area lacking in the TTM system. In the final stage of the path to a persuasive habit-forming learning system, the behavioural data analysed during the second phase could further the role of the persuasive learning system as a recommender and actively assist students with identifying sub-optimal study behaviours, suggesting ways they could improve their performance. In keeping with the flexibility finding of this research, the system should tailor recommendations for specific students, taking into consideration their non-academic commitments. This phase would also stand to benefit from implementing the Hook model cycle (described in section 2.3.3), where students are sent a trigger, asked to perform an action, are provided with a variable reward and create an investment into the continued use of the system. The amount of personal information required to enable this type of functionality would be large, and so such a system would need to be carefully designed. This would also provide an opportunity to explore the ethics of a persuasive learning system.
8.7.4 Gamification and social interaction

Chapter 2 raised the possibility of utilising gamification to better engage students. One of the limitations of using gamification to drive an overall system design philosophy is that there is a lack of research that explains how it can function as a design guideline or framework. However, gamification is well suited as a means to address specific interaction issues. One area of the PSD framework that TTM lacked was social support. The interviews with students revealed that social interaction could be a useful addition to the system and encourage students to complete more coursework. Gamification lends itself to social features since a key element of gamification is aspects such as rewards, competition and teamwork. Future work could be designed to augment TTM’s social implementation by adding rewards such as badges for completing tasks and tests. Students could also compete with one another in obtaining scores or progressing through the course. This would require considerable thought on how to implement it effectively, as creating a competitive learning environment may have the adverse effect of discouraging students from wanting to get involved for fear of embarrassment.

Building and testing such a system could also provide justification for research that explores the relationship between gamification and PSD. This thesis held the view that gamification can be used to implement some of the PSD, and that they exist on different levels of abstraction. PSD is more suited to strategic implementation of systems to influence behaviour, whereas gamification covers the operational aspects of implementing a system to influence behaviour. This relationship and hierarchy should be explored further as it will help designers create more influential systems and strengthen each field’s position in both research and practice. By understanding the roles each plays best, implementations will make better use of the theory, which may encourage more researchers and designers to take up such work.

8.7.5 Learning analytics and recommender systems

Developing persuasive learning systems can also assist with enhancing other areas of learning technology. One such area is in improving data collection in learning analytics software. By persuading students to better engage with coursework in a system, more data can be collected on student learning progress. The coursework that is typically unassessed could be measured, for example, by testing knowledge of a topic using multiple-choice tests, as in TTM. Further, a persuasive DLE could also be designed to capture data related to when and how students
interact with the system. Data such as time and location of access could highlight the behavioural patterns of students and the impact completing coursework at specific times and locations has on learning outcomes. This data could then be aggregated and used to personalise features in the system to suit individual student learning styles to maximise their potential academic performance. Data could also be used to predict common barriers that inhibit students’ ability to perform optimally and provide appropriate interventions. Interventions might involve notifying instructors of detected difficulties students are facing. Alternatively, the system could take the role of a learning recommender system that assists students in the areas they need to focus on. For example, with large amounts of historical interaction data, the system might inform current students that previous students who struggled with a certain topic improved after they completed a certain task or test. This approach could also be considered an extension of the guidance factor identified in this thesis.

8.8 Concluding Remarks

Modern computing has dramatically altered society since its introduction several decades ago. As computing power increases, it continues to provide unprecedented levels of support. In addition, higher living standards have seen greater numbers of students entering tertiary education from an increasingly wider variety of backgrounds. This has led to many students entering higher education programs with certain expectations, particularly in how courses should accommodate their personal circumstances. To cope with this change in attitude, tertiary institutions should embrace these changes and utilise the same technology that shifted attitudes and behaviours in students to recalibrate them towards performing well academically. This thesis has demonstrated that the digital learning systems students use are capable of influencing behaviour and are perceived to be persuasive from the student point of view. The results of this research are encouraging for all institutions attempting to find a competitive edge by accommodating complex student needs while not sacrificing the quality of the education they provide. Persuasive learning systems are an opportunity to bridge the gap between the traditional system of higher education and the challenges of maintaining the inevitable change of the future.
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Appendix A: MSLQ Scale Definitions

The following is a list of the MSLQ scales and sub-scales and their corresponding definitions. The definitions are reproduced from Pintrich (1991).

Intrinsic Goal Orientation

Goal orientation refers to the student’s perception of the reasons why she is engaging in a learning task. On the MSLQ, goal orientation refers to student’s general goals or orientation to the course as a whole. Intrinsic goal orientation concerns the degree to which the student perceives herself to be participating in a task for reasons such as challenge, curiosity, and mastery. Having an intrinsic goal orientation towards an academic task indicates that the student’s participation in the task is an end all to itself, rather than participation being a means to an end.

Extrinsic Goal Orientation

Extrinsic goal orientation complements intrinsic goal orientation, and concerns the degree to which the student perceives herself to be participating in a task for reasons such as grades, rewards, performance, evaluation by others, and competition. When one is high in extrinsic goal orientation, engaging in a learning task is the means to an end. The main concern the student has is related to issues that are not directly related to participating in the task itself (such as grades, rewards, comparing one’s performance to that of others). Again, this refers to the general orientation to the course as a whole.

Task Value

Task value differs from goal orientation in that task value refers to the student’s evaluation of the how interesting, how important, and how useful the talk is (“What do I think of this task?). Goal orientation refers to the reasons why, the student is participating in the task (“Why am I doing this?”). High task value should lead to more involvement in one’s learning. On the MSLQ, task value refers to students’ perceptions of the course material in terms of interest, importance, and utility

Control of Learning Beliefs

Control of learning refers to students’ beliefs that their efforts to learn will result in positive outcomes. It concerns the belief that outcomes are contingent on one’s own effort, in contrast
to external factors such as the teacher. If students believe that their efforts to study make a difference in their learning, they should be more likely to study more strategically and effectively. That is, if the student feels that she can control her academic performance, she is more likely to put forth what is needed strategically to effect the desired changes.

**Self-Efficacy**

The items comprising this scale assess two aspects of expectancy: expectancy for success and self-efficacy. Expectancy for success refers to performance expectations, and relates specifically to task performance. Self-efficacy is a self-appraisal of one’s ability to master a task. Self-efficacy includes judgments about one’s ability to accomplish a task as well as one’s confidence in one’s skills to perform that task.

**Test Anxiety**

Test anxiety has been found to be negatively related to expectancies as well as academic performance. Test anxiety Li thought to have two components: a worry, or cognitive component, and an emotionality component. The worry component refers to students’ negative thoughts that disrupt performance, while the emotionality component refers to affective and physiological arousal aspects of anxiety. Cognitive concern and preoccupation with performance have been found to be the greatest sources of performance decrement. Training in the use of effective learning strategies and test-taking skills should help reduce the degree of anxiety.

**Rehearsal**

Basic rehearsal strategies involve reciting or naming items from a list to be learned. These strategies are best used for simple tasks and activation of information in working memory rather than acquisition of new information in long-term memory. These strategies are assumed to influence the attention and encoding processes, but they do not appear to help students construct internal connections among the information or integrate the information with prior knowledge.

**Organisation**

Organization strategies help the learner select appropriate information and also construct connections among the information to be learned. Examples of organizing strategies are clustering, outlining, and selecting the main idea in reading passages. Organizing is an active,
effortful endeavour, and results in the learner being closely involved in the task. This should result in better performance.

**Critical Thinking**

Critical thinking refers to the degree to which students report applying previous knowledge to new situations in order to solve problems, reach decisions, or make critical evaluations with respect to standards of excellence.

**Metacognitive Self-regulation**

Metacognition refers to the awareness, knowledge, and control of cognition. We have focused on the control and self-regulation aspects of metacognition on the MSLQ, not the knowledge aspect. There are three general processes that make up metacognitive self-regulatory activities: planning, monitoring, and regulating. Planning activities such as goal setting and task analysis help to activate, or prime, relevant aspects of prior knowledge that make organizing and comprehending the material easier. Monitoring activities include tracking of one’s attention as one reads, and self-testing and questioning: these assist the learner in understanding the material and integrating it with prior knowledge. Regulating refers to the fine-tuning and continuous adjustment of one’s cognitive activities. Regulating activities are assumed to improve performance by assisting learners in checking and correcting their behaviour as they proceed on a task.

**Time and Study Environment**

Besides self-regulation of cognition, students must be able to manage and regulate their time and their study environments. Time management involves scheduling, planning, and managing one’s study time. This includes not only setting aside blocks of time to study, but the effective use of that study time, and setting realistic goals. Time management varies in level, from an evening of studying to weekly and monthly scheduling. Study environment management refers to the setting where the student does her class work. Ideally, the learner’s study environment should be organized, quiet, and relatively free of visual and auditory distractions.

**Effort Regulation**

Self-regulation also includes students’ ability to control their effort and attention in the face of distractions and uninteresting tasks. Effort management is self-management, and reflects a commitment to completing one’s study goals, even when there are difficulties or distractions.
Effort management is important to academic success because it not only signifies goal commitment, but also regulates the continued use of learning strategies.

**Elaboration**

Elaboration strategies help students store information into long-term memory by building internal connections between items to be learned. Elaboration strategies include paraphrasing, summarizing, creating analogies, and generative note-taking. These help the learner integrate and connect new information with prior knowledge.

**Peer Learning**

Collaborating with one’s peers has been found to have positive effects on achievement. Dialogue with peers can help a learner clarify course material and reach insights one may not have attained on one’s own.

**Help Seeking**

Another aspect of the environment that the student must learn to manage is the support of others. This includes both peers and instructors. Good students know when they don’t know something and are able to identify someone to provide them with some assistance. There is a large body of research that indicates that peer help, peer tutoring, and individual teacher assistance facilitate student achievement.
Appendix B: MSLQ Survey Instrument

The following table presents all of the questions included in the academic performance survey that was distributed online. MSLQ questions are adapted from Pintrich (1991).

<table>
<thead>
<tr>
<th>Demographic Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which age range do you fall in?</td>
</tr>
<tr>
<td>What is your sex?</td>
</tr>
<tr>
<td>What is your current status?</td>
</tr>
<tr>
<td>Which of the following describes your predominant academic load?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Academic Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you describe your academic performance as a student?</td>
</tr>
<tr>
<td>How often did you receive high grades (of 80% or over) for assignments, exams or subjects overall?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MSLQ Motivation Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value Component: Intrinsic Goal Orientation</td>
</tr>
<tr>
<td>In class, I prefer course material that really challenges me so I can learn new things.</td>
</tr>
<tr>
<td>I prefer course material that arouses my curiosity, even if it is difficult to learn.</td>
</tr>
<tr>
<td>The most satisfying thing for me in a course is trying to understand the content as thoroughly as possible.</td>
</tr>
<tr>
<td>When I have the opportunity in class, I choose course assignments that I can learn from even if they don’t guarantee a good grade.</td>
</tr>
</tbody>
</table>

| Value Component: Extrinsic Goal Orientation |
| Getting a good grade is the most satisfying thing for me. |
| The most important thing for me is improving my overall grade point average, so my main concern in a class is getting a good grade. |
| If I can, I want to get better grades in a class than most of the other students. |
| I want to do well in a class because it is important to show my ability to my family, friends, employer, or others. |

| Value Component: Extrinsic Task Value |
| I think I will be able to use what I learn in this course in other courses. |
| It is important for me to learn the course material for a course. |
| I am very interested in the content area of this course. |
| I think the course material in this class is useful for me to learn. |
| I like the subject matter of this course. |
| Understanding the subject matter of a course is very important to me. |
Expectancy Component: Control of Learning Beliefs

If I study in appropriate ways, then I will be able to learn the course material.

It is my own fault if I don’t learn the material in a course.

If I try hard enough in a course, then I will understand the course material.

If I don’t understand the course material, it is because I didn’t try hard enough.

Expectancy Component: Self-Efficacy for Learning and Performance

I believe I will receive an excellent grade in this class.

I’m certain I can understand the most difficult material presented in the readings for a subject.

I’m confident I can learn the basic concepts taught in a course.

I’m confident I can understand the most complex material presented by the instructor in a course.

I’m confident I can do an excellent job on the assignments and tests in a course.

I expect to do well in my classes.

I’m certain I can master the skills being taught in a class.

Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class.

Affective Component: Test Anxiety

When I take a test, I think about how poorly I am doing compared with other students.

When I take a test I think about items on other parts of the test I can’t answer.

When I take tests I think of the consequences of failing.

I have an uneasy, upset feeling when I take an exam.

I feel my heart beating fast when I take an exam.

Learning Strategies Scales

Cognitive and Metacognitive Strategies: Rehearsal

When I study for a class, I practice saying the material to myself over and over.

When studying for a course, I read my class notes and the course readings over and over again.

I memorize key words to remind me of important concepts for a class.

I make lists of important items for the course and memorize the lists.

Cognitive and Metacognitive Strategies: Elaboration

When I study for a class, I pull together information from different sources, such as lectures, readings, and discussions.

I try to relate ideas in a subject to those in other courses whenever possible.

When reading for a class, I try to relate the material to what I already know.
When I study for a course, I write brief summaries of the main ideas from the readings and my class notes.

I try to understand the material in a class by making connections between the readings and the concepts from the lectures.

I try to apply ideas from course readings in other class activities such as lecture and discussion.

**Cognitive and Metacognitive Strategies: Organisation**

When I study the readings for a course, I outline the material to help me organize my thoughts.

When I study for a course, I go through the readings and my class notes and try to find the most important ideas.

I make simple charts, diagrams, or tables to help me organize course material.

When I study for a course, I go over my class notes and make an outline of important concepts.

**Cognitive and Metacognitive Strategies: Critical Thinking**

I often find myself questioning things I hear or read in a course to decide if I find them convincing.

When a theory, interpretation, or conclusion is presented in class or in the readings, I try to decide if there is good supporting evidence.

I treat the course material as a starting point and try to develop my own ideas about it.

I try to play around with ideas of my own related to what I am learning in the course.

Whenever I read or hear an assertion or conclusion in a class, I think about possible alternatives.

**Cognitive and Metacognitive Strategies: Metacognitive Self-Regulation**

During class time I often miss important points because I’m thinking of other things.

(reverse coded)

When reading for a course, I make up questions to help focus my reading.

When I become confused about something I’m reading for a class, I go back and try to figure it out.

If course readings are difficult to understand, I change the way I read the material.

Before I study new course material thoroughly, I often skim it to see how it is organized.

I ask myself questions to make sure I understand the material I have been studying in a class.

I try to change the way I study in order to fit the course requirements and the instructor’s teaching style.

I often find that I have been reading for a class but don’t know what it was all about.

(reverse coded)

I try to think through a topic and decide what I am supposed to learn from it rather than just reading it over when studying for a course.
When studying, I try to determine which concepts I don’t understand well. When I study, I set goals for myself in order to direct my activities in each study period. If I get confused taking notes in class, I make sure I sort it out afterwards.

**Resource Management Strategies: Time and Study Environment**

I usually study in a place where I can concentrate on my course work.

I make good use of my study time for my courses.

I find it hard to stick to a study schedule. (reverse coded)

I have a regular place set aside for studying.

I make sure that I keep up with the weekly readings and assignments for a course.

I attend class regularly.

I often find that I don’t spend very much time on a course because of other activities. (reverse coded)

I rarely find time to review my notes or readings before an exam. (reverse coded)

**Cognitive and Metacognitive Strategies: Effort Regulation**

I often feel so lazy or bored when I study for a class that I quit before I finish what I planned to do. (reverse coded)

I work hard to do well in a class even if I don’t like what we are doing.

When course work is difficult, I either give up or only study the easy parts. (reverse coded)

Even when course materials are dull and uninteresting, I manage to keep working until I finish.

**Cognitive and Metacognitive Strategies: Peer Learning**

When studying for a course, I often try to explain the material to a classmate or friend.

I try to work with other students to complete the course assignments.

When studying for a course, I often set aside time to discuss course material with a group of students from the class.

**Cognitive and Metacognitive Strategies: Help Seeking**

Even if I have trouble learning the material in a class, I try to do the work on my own, without help from anyone. (reverse coded)

I ask the instructor to clarify concepts I don’t understand well.

When I can’t understand the material in a course, I ask another student in the class for help.

I try to identify students whom I can ask for help if necessary.
Appendix C: Persuasive Evaluation Survey Instrument

The following table lists all of the questions included in the persuasive learning system experience survey instrument. Questions specifically enquiring about the PSD scale were adapted from Lehto, Oinas-Kukkonen and Drozd (2012).

<table>
<thead>
<tr>
<th>Demographic Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which program are you enrolled in?</td>
</tr>
<tr>
<td>Which course are you enrolled in?</td>
</tr>
<tr>
<td>Which age range do you fall in?</td>
</tr>
<tr>
<td>What is your sex?</td>
</tr>
<tr>
<td>What is your current status?</td>
</tr>
<tr>
<td>Which of the following describes your predominant academic load?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many times have you used TTM per week on average?</td>
</tr>
<tr>
<td>Did you install the TTM Study Helper app?</td>
</tr>
<tr>
<td>How many times have you used the TTM Study Helper app per week on average? (please circle)</td>
</tr>
<tr>
<td>How many times have you used TTM per week on average?</td>
</tr>
<tr>
<td>Has TTM helped you with managing your time for this course?</td>
</tr>
<tr>
<td>Would you like to see TTM used in your other courses?</td>
</tr>
<tr>
<td>How frequently did you complete the tasks?</td>
</tr>
<tr>
<td>How useful did you find the tasks?</td>
</tr>
<tr>
<td>Which statement best reflects why you completed tests?</td>
</tr>
<tr>
<td>What score were you aiming to achieve on the tests?</td>
</tr>
<tr>
<td>Generally, how many attempts did it take you to achieve your desired score?</td>
</tr>
<tr>
<td>How useful did you find the tests?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Persuasive system design Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTM provides me with a way to study.</td>
</tr>
<tr>
<td>TTM helps me keep up to date with course work.</td>
</tr>
<tr>
<td>TTM helps me change my approach to studying.</td>
</tr>
<tr>
<td>TTM provides me with appropriate feedback.</td>
</tr>
<tr>
<td>TTM provides me with appropriate counselling.</td>
</tr>
<tr>
<td>TTM encourages me.</td>
</tr>
<tr>
<td>TTM is trustworthy.</td>
</tr>
</tbody>
</table>
TTM is reliable.
TTM shows expertise.
TTM instils confidence.
TTM is clearly made by lecturers/tutors.
The screens in TTM (i.e., colours, layout, etc.) are attractive.
The general appearance of TTM is appealing.
TTM provides a nice visual experience.
TTM has an influence on me.
TTM is personally relevant for me.
TTM makes me reconsider the way I study.
Using TTM fits into my daily life.
Using TTM disrupts my daily routines.
Using TTM is practical / convenient for me.
Finding the time to use TTM is not a problem for me.
Appendix D: Study Tips

The following is a list of all of the Study Tips that are presented in the TTM system to students.

Be resourceful
How many places are you looking for information from? Make sure you cover a range of sources, such as lecture notes, readings and other course materials.

Persistence pays off
Feeling lazy or bored while studying? Don’t give up! TTM believes in you!

Keep with it
Studying the easy parts is a great confidence booster, but studying the hard parts is what will improve your grades.

Wait, what?
Didn’t quite understand something in the lecture? Talk to your lecturer as soon as you can to sort it out.

I know I can do it
The more you read about it, the more confident you’ll be in understanding the subject.

Practise run
Attempt the TTM tests as many times as you need so that you’re better prepared for assessments.

Do not disturb
Get easily distracted in class? Try turning on the “do not disturb” features of your phone or computer.

Let me just note that down
A great way to revise for exams is to review your notes. Note to self: starting taking more notes.
Reusable knowledge
Having problems remembering class concepts? Take an idea you’ve learned recently and try to apply it to a class discussion.

I need a change of scenery
Finding it hard to concentrate on your work? Think about changing where you’re studying to somewhere that suits you better.

I plan to stay on schedule
Every TTM task has an expected time at the top. Use that to help plan bite-sized study sessions.

Shout it out aloud
Between your lecturers, tutors, and friends, there’s plenty of help available if you’re having trouble with the coursework.

In summary...
Writing brief summary notes of the main ideas is known to improve your overall learning performance.

Meet me at the cafe
Go and have a coffee with someone from class and try to find time to talk about the class material with them.

Be a fact checker
“Is that actually true?” When presented with information in class, try to find supporting evidence.

I’m goal-oriented
Keep on track while studying by setting challenging yet achievable goals for yourself.

Convince me
Don’t take everything you read on face value. Question it and decide if you think the argument is convincing.

Mix it up
Try to change up the way you study so that it matches how the class works.
Public forum
Get a group of people from class and set aside some time to talk about the work you're doing.

Practise makes perfect
Repeating key ideas to yourself helps make you a higher achiever in the long run. Repeating key ideas...

I understand
It’s important to be confident in your ability to learn new things. This happens over time by consistently working on it.

Just take another step
You’re probably not going to like every aspect of what you’re studying, but pushing through it has shown to increase learning achievement in the long run.

It’s all relative
Try to relate your own ideas to what you’re learning in class to improve your learning performance over time.

Keep it simple
Einstein said: “Everything should be made as simple as possible, but not simpler”. Break down complex concepts into keywords to help you remember and understand it.

Read with a purpose
Before reading a chapter or course notes, make up some questions to help focus your reading.
Appendix E: Factor Analysis Scree Plot

The following image is a scree plot generated by the SPSS software package.