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Evaluating Persuasion in a Digital Learning Environment

Justin Filippou
University of Melbourne, justin.filippou@unimelb.edu.au

Christopher Cheong
RMIT University, chris.cheong@gmail.com

France Cheong
RMIT University, france.cheong@gmail.com

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Full Paper

Justin Filippou[1]
School of Computing and Information Systems
University of Melbourne
Melbourne, Australia
Email: justin.filippou@unimelb.edu.au

Christopher Cheong
School of Business IT & Logistics
RMIT University
Melbourne, Australia
Email: christopher.cheong@rmit.edu.au

France Cheong
School of Business IT & Logistics
RMIT University
Melbourne, Australia
Email: france.cheong@rmit.edu.au

Abstract

The massification of higher education has produced cohorts of students with varying motivation and ability to meet their academic potential. Providing individualised support is not always feasible for instructors as class sizes continue to grow, so this research evaluates the persuasive design of a digital learning environment (DLE) to address the aforementioned issue. A system with persuasive features called Task-Test-Monitor (TTM) was used by students for a semester at an Australian university. At the conclusion of the semester, students were surveyed on their experience of using the system. Results showed students were strongly in favour of using such a system to help them study, with a significant portion of respondents reporting that the system influenced how they studied. Educators and system designers can benefit from these findings by applying persuasive design principles used in this research in their own pedagogy or system designs.

Keywords: persuasive systems, higher education, digital learning environments, technology enhanced learning, behaviour change

[1] Justin Filippou was employed at RMIT University while conducting this research.

1 INTRODUCTION

More students than ever are attending university to complete undergraduate studies and there is a broader range of these students' academic ability. This has been described as the "massification" of education (Guri-Rosenblit et al. 2007; Norton et al. 2013) and has impacted universities across the world (Chan and Huang 2018; Mohamedbhai 2014; Yang 2004). Problematically, the learning environments used to teach students have not adapted to meet the needs of the more diverse student cohort (QUT 2014). One way to address this is for modern universities to take a more student-centred approach in designing learning systems by moving from a "one size fits all" style to a more tailored learning environment (Sledge and Fishman 2014). Students are also diversifying their interests away from formal study and are increasingly working part-time while they study (ABS 2013), dividing their attention and creating larger amounts of time away from academic responsibilities.

As more students enter higher education with varied interest, motivation and ability to perform at the highest level, some form of intervention will be required to better engage students. However, with enrolment numbers continuing to increase, it will become decreasingly feasible for teaching staff to provide the tailored learning experience expected by students. Personalising learning for individual students may take too much time away from teaching responsibilities to the cohort of students in general and so a more feasible solution is to leverage an information system to assist both teaching staff and students. One solution that could be used is a persuasive system, which is one that is designed and implemented in such a way as to encourage deliberate behavioural responses from end users (Fogg 2002; Oinas-Kukkonen and Harjumaa 2009). Such systems have been shown to be effective in health and exercise (Karppinen et al. 2016; Langrial et al. 2012), environmental sustainability (De Kort et al. 2008) and computer security (Forget et al. 2008). The aim of this research is to evaluate a persuasive system for the learning environment (or Persuasive Learning System) and the ways that it can be used in encouraging students to engage with coursework.

2 BACKGROUND

The research presented in this paper forms one segment of a larger research project on persuasive systems for learning. Overall there are three phases to the project, of which this research marks the beginning of the third phase. Phase 1 surveyed students to understand their study behaviour and uncover barriers to successful study (Filippou et al. 2016). Phase 2 enhanced a learning system using persuasive principles and incorporated the study behaviour findings from the first phase. The aim of phase 3 is to evaluate the persuasiveness of the target learning system in order to inform the development of design principles that other educators and learning designers will be able to implement to address issues of engagement. This section provides context for the targeted study behaviours and explains how behaviour can be triggered, the process in which a persuasive system can be designed and evaluated and finally how persuasive systems have been a useful tool in identifying issues in other disciplines.

2.1 Study Behaviour Models

To carry out phase 1 (Filippou et al. 2016), an existing study behaviour survey instrument called the Motivated Strategies for Learning Questionnaire (MSLQ) was used. The instrument features 81 items that cover a range of different study behaviours across several categories of behaviour and motivation (Pintrich 1991). Automatic linear modelling (ALM) was 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. These two measures were used to provide a balance of subjective and objective perspective from respondents. The results of the ALM were used to perform multiple linear regression (MLR) in order to identify three to five of the most impactful behaviours on each of the performance criteria. The process was 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. The models informed the enhanced persuasive design of the digital learning environment used for this research. The system and its persuasive features are further explained in section 3.

2.2 Behaviour Change

There is an unstated assumption that behaviour simply occurs, but it can be argued that behaviour is driven by two aspects: motivation and ability. The theory of planned behaviour, for example, represents these constructs as behavioural intention and perceived behavioural control, respectively (Ajzen 1985). However, it does not specify any trigger mechanism to begin the process of behaviour change. One model that does this is the Fogg Behavioural Model (FBM). The FBM helps improve the understanding of

behavioural processes by mapping the relationship between motivation and ability with the point behavioural triggers can be effective (Fogg 2009). Triggers can only be effective when an individual has both sufficient motivation and ability to perform the action. 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. The FBM is a useful tool to diagnose issues with behaviour or at least to better understand how behaviour functions generally. However, the model does not provide guidance on how to systematically design an intervention to achieve desired behaviour change in people. A framework that can be used for such guidance is Persuasive Systems Design (PSD).

2.3 Persuasive Systems Design

The PSD model merges various work on psychology, influence, behaviour and system design 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 and Harjumaa 2009). 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 focuses on 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 components of persuasion. Such components used in this research will be explained in later sections.

2.4 Related Work

One of the strengths of the PSD is that it can be used for both designing and evaluating persuasive systems. In a study that used the PSD as an evaluation tool to evaluate the persuasiveness of various weight loss websites, the authors were able to find common strengths and weaknesses and the overall persuasiveness of those types of systems (Lehto and 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, which is the primary goal of this research. In the following section, the system that the PSD will be applied against for evaluation will be described.

3 SYSTEM OVERVIEW

The target system used in this research is called Task-Test-Monitor (TTM). TTM is a Next-generation Digital Learning Environment that supports students in completing weekly tutorial tasks. 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 1) 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 3.1) to make them easier to complete. On the right-hand side of the screen there are the automated to-do list (see section 3.2). The performance area of TTM tells students how they are progressing through their course (see section 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 intended persuasive effect of the DLE. The following sub-sections detail the design choices for each persuasive feature and how they align with the existing behaviours identified in phase 1 of the broader research project.

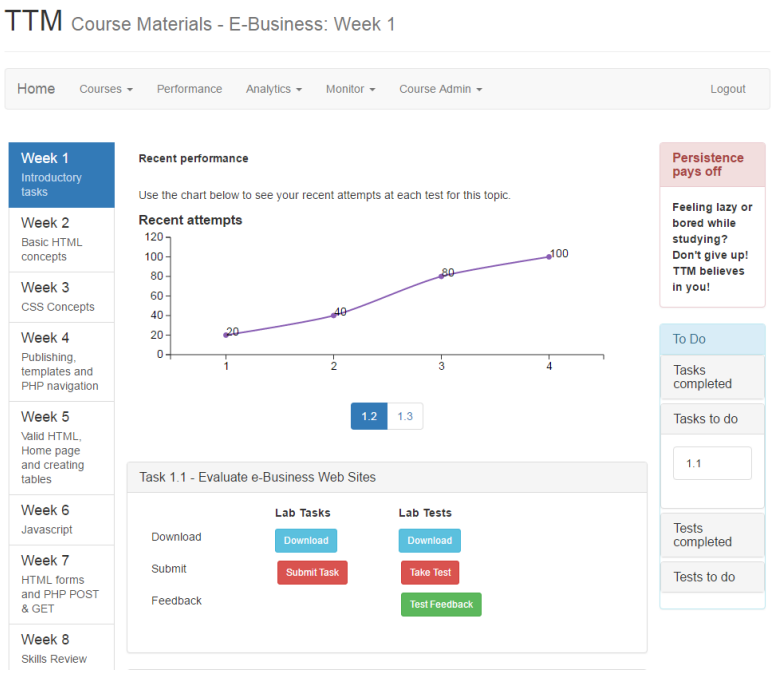

Figure 1: Overview of the TTM structure

3.1 Bite-sized tasks and tests

To varying degrees, 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 (Filippou et al. 2016). One explanation 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 (Hug and Friesen 2007) can address these common student issues by breaking down content into smaller manageable pieces, targeting the following five study behaviours and strategies identified in phase 1 of the research:

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, which involves reducing complex behaviour into simple tasks to increase the benefit/cost ratio of performing behaviour.

Another 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 and Pychyl 2000; Harrington 2005; Milgram et al. 1988). Therefore, by dividing tutorial tasks into smaller pieces, students would be required 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 prerequisites before commencing. After the task is completed, students are presented with the next steps (contained in the task instructions), thereby providing a basic level of "tunnelling", which involves guiding users through a process or experience. 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" (simply being able to rehearse the desired behaviour), 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 (behaviour 1) as 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.

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 a behaviour identified in phase 1: "*I find it hard to stick to a study schedule.*" 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, built-in to-do lists were designed into TTM to automatically track what has been completed, including both tasks and tests. 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. The intended effect of the to-do list is that students will be more likely to seek out the tasks and tests they are yet to complete and then do so.

3.3 Visualisation

Capturing students attention quickly has been shown to be an effective persuasive strategy (Orji et al. 2018). One way to achieve that is through visualisation. The most prominent use of visualisation in TTM are the use of bars measuring progression of course completion, the task and test performance charts and the recent test attempts chart. 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. Being able to measure learning performance can help support one of the behaviours identified in the first phase of the broader research project: *"When I study, I set goals for myself in order to direct my activities in each study period"*.

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 the PSD elements of "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 addressing the aforementioned study behaviour. This is a valuable feature considering that students are likely to use the system in bursts, particularly if they have external work commitments. Quickly making students aware of what their next task or test is and then reminding them of their overall progression in the course is expected to more effectively trigger students to re-engage with coursework. As a result, less time and effort are expended on re-acquainting students with that they should be doing, and instead more time and effort can be dedicated to completing coursework.

The most basic view of student progress in TTM is found in the performance section, where students can see how much they have completed for each course using TTM. To register as completed, students must score 80% or higher. The figure of 80% is set in accordance with the mastery learning theory (Block and Burns 1976), but it also acts as a 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 et al. 2006). Although the 80% result to register as complete and the nature of progress bars are individually subtle in design, they should have a combined positive persuasive effect of motivating students to continue working throughout a semester and help them identify problem areas for tests.

4 METHODOLOGY

For persuasion to be measured, students need to use the persuasive learning system for a considerable amount of time. In this research, students use TTM in class for an entire semester of 12 weeks. Students are shown all of the features of the system and how to use them in the first week of classes. TTM is 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. Students are given general recommendations to first complete tasks and then complete tests, in that order. Instructors are asked to provide regular consultations every two to three weeks to monitor whether students complete work and address any concerns that arise. At the conclusion of the semester, students were invited to complete a survey questionnaire about their experience of using TTM.

4.1 Survey instrument design

A survey instrument was constructed to collect data about 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 persuasive impact questions are adapted from a related study that surveyed users about a health-based behaviour change support system (Lehto et al. 2012). That study's questionnaire survey consisted 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 were 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"*. All questions in the PSD evaluation section use a five-point Likert scale ranging from "very much agree" to "very much disagree".

5 RESULTS AND DISCUSSION

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 be impacted. Table 1 summarises the demographic (demo.) and percentage of respondents (resp.) of the survey respondents.

Demo.	**Resp.**	**Demo.**	**Resp.**	**Demo.**	**Resp.**
Gender		*Program*		*Study Load*	
Male	67%	Bachelor of Business/IT	69%	Full-time	85%
Female	33%	Other (Social Sciences)	31%	Part-time	15%
Student type		*Course*		*Age*	
Local	73%	Systems Development	25%	18–21	45%
International	27%	E-Business	40%	22–25	35%
		Mobile Systems	21%	26–29	6%
		Research Methods in Social Sciences	14%	30–39	8%
				40+	6%

Table 1: Demographics of survey respondents

5.1 Use of Task-Test-Monitor

It was found that the system was regularly used with 16% of students reporting that they used 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. 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.

Further, 72% of respondents stated that they would like to see TTM used in their other courses. Intention to use a system in the future is a factor in the technology acceptance model (Davis 1989), so this provides basic evidence for general acceptance of the system. Respondents were also asked whether TTM assisted them with managing their time for the course, 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 the earlier phases of the broader research project 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, 36% of respondents were unsure of whether this help occurred, so further investigation is required. Table 2 presents the results of the three questions related to student use of TTM.

How many times have you used TTM per week on average?		**Would you like to see TTM used in your other courses?**		**Has TTM Helped you in managing your time in this course?**	
Scale	*Respondents*	*Scale*	*Respondents*	*Scale*	*Respondents*
0	8%	No	15%	No	16%
1-2	46%	Unsure	13%	Unsure	36%
3-4	30%	Yes	72%	Yes	48%
5+	16%				

Table 2: TTM usage survey results

5.2 Task completion

Analysing lower-level system usage, the survey results showed that 66% of students regularly completed the tasks (either most of the time or all of the time), 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. These students were likely either 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, it should be noted that only 3% never submitted the tasks. This implies that some 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. Table 3 shows the respondents views regarding task completion in TTM.

How frequently did you complete the tasks?		**How useful did you find the tasks?**	
Scale	*Respondents*	*Scale*	*Respondents*
Never	3%	Not useful at all	5%
Some of the time	31%	Somewhat useful	45%
Most of the time	45%	Very useful	50%
All of the time	21%		

Table 3: Task completion survey results

5.3 Test completion

Following the high levels of completion of tasks, many respondents (97%) also completed the tests, albeit for varying reasons. 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 and may also be a symptom of surface learning as students tend to perceive MCQ-style work as less demonstrative of skills and therefore less important to complete (Scouller 1998). 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.

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. 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". 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 Fogg Behavioural Model (Fogg 2009), 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. This result gives an early indication that students, contrary to popular belief, are not unmotivated to study; rather, it may be more likely that restrictions on their ability to study hampers their academic performance. Table 4 contains the results in which participants reported their interaction with the test functionality of TTM.

What score were you aiming to achieve on the tests?		**How useful did you find the tests?**		**Generally, how many attempts did it take you to achieve your desired score?**	
Scale	*Respondents*	*Scale*	*Respondents*	*Scale*	*Respondents*
Didn't care	5%	Not useful at all	3%	1	15%
Pass	3%	Somewhat useful	54%	2-3	79%
60%	2%	Very useful	43%	4 or more	6%
80%	15%				
100%	75%				

Which statement best reflects how you completed the tests?	
Scale	*Respondents*
I didn't take the tests	3%
I did the tests when I was catching up on my studies	27%
I took the tests regularly at first but then stopped	22%
I regularly took the tests after my tutorial	31%
I regularly took the tests before my tutorial	17%

Table 4: Test completion survey results

5.4 Impact on study behaviour

The results for TTM's ability to persuade study behaviour were positive. Of respondents, 46% agreed that TTM made them reconsider the way they studied, and 61% stated that it helped change their approach to study. Furthermore, respondents reported that TTM was able to encourage them (47% agreed), instil confidence (49% agreed) and have an influence on them (41% agreed). Very few disagreed completely, however, there were considerable numbers of respondents who neither agreed nor disagreed that TTM influenced their study process or behaviour. One explanation for 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. Misremembering one's attitude pre- and post-intervention is possible (Bem and McConnell 1970), which may be what has occurred in this instance. Alternatively, the questions that lead the respondent to consider how it made them "reconsider" the way they study and how it changed their "approach" to studying had lower levels of neutrality. Observing the items related to impact on behaviour, those questions imply TTM directly altered their behaviour regardless of whether it was desired. Respondents may have had a natural hesitation to admit that a system could have that level of control or influence on behaviour and may be more comfortable with persuasion occurring when they are in control of their learning process with TTM simply assisting them. This is an important finding for persuasive DLE

because it indicates that students need to believe they retain control even if they are being influenced, even when there is clearly no coercion taking place in a system. Table 5 contains reported results on how TTM impacted student study behaviour.

TTM makes me reconsider the way I study.		**TTM helps me change my approach to studying**	
Scale	*Respondents*	*Scale*	*Respondents*
Strongly Disagree	5%	Strongly Disagree	3%
Disagree	21%	Disagree	10%
Neutral	28%	Neutral	26%
Agree	30%	Agree	43%
Strongly Agree	16%	Strongly Agree	18%

TTM encourages me.		**TTM instils confidence.**		**TTM has an influence on me.**	
Scale	*Value*	*Scale*	*Value*	*Scale*	*Value*
Strongly Disagree	3%	Strongly Disagree	3%	Strongly Disagree	3%
Disagree	7%	Disagree	7%	Disagree	23%
Neutral	43%	Neutral	41%	Neutral	33%
Agree	34%	Agree	42%	Agree	33%
Strongly Agree	13%	Strongly Agree	7%	Strongly Agree	8%

Table 5: Impact on study behaviour survey results

6 IMPLICATIONS AND RECOMMENDATIONS

The results in the previous section clearly indicate that the design of the TTM Digital Learning Environment was conducive to persuasion and that students demonstrated a preference for this kind of intervention. The results also provide evidence of microlearning being well-suited to persuasive design as the nature of making tasks more manageable fits very well with a number of the persuasive features designers can implement. This result does not preclude other learning pedagogies from working with persuasive design, rather that in this case it appears to have been a good match.

A recommendation for educators resulting from this research is to assess their current digital learning environment against the Persuasive Systems Design framework and identify areas that could be improved. Feature implementation should be carried out with a student-centred focus by first performing an appropriate study of current behavioural issues exhibited by students. The design of a persuasive system intervention will also need to be tailored to particular cases for issues of either motivation or ability. More specifically, educators and system designers should prioritise the concept of reduction in order to address issues of procrastination deriving from a lack of motivation or ability.

7 LIMITATIONS AND FUTURE WORK

This research is exploratory in nature and so the results are not generalisable in their current form. More data will need to be collected across various study disciplines to validate the results. 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. 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.

The results of this research are encouraging as there is evidence to suggest that learning systems can be persuasive in influencing student study behaviour. This research is a foundational step towards better understanding how that persuasion occurs in a DLE, and what factors contribute to it being effective. To achieve this, future work may focus on conducting a factor analysis to reveal a better understanding of how and why students felt TTM had an influence on their learning experience. This would be achieved by examining the impact certain features have on learning behaviour. Such an analysis would be beneficial to researchers as the key aspects of persuasion can be isolated and then replicated in other learning systems. Longer term goals would be to enhance the PSD by providing more guidance to designers on how to design for persuasion, particularly in a learning system.

8 SUMMARY

This research has presented an evaluation on the potential for a learning system to persuade students to better engage with their coursework. There is a growing need for Digital Learning Environments to be more persuasive, as universities are facing a wider range of motivated students. To address this problem, this research selected a Next-Generation Digital Learning Environment called Task-Test-Monitor (TTM) and assessed its persuasive ability. This research found that the design of a learning system can have an impact on student behaviour and that students are aware that such a system can be influential. In particular, TTM provided high-levels of primary task support and credibility, which made it an effective tool for persuasion. Students self-reported that it encouraged and influenced them to change their approach to study, which provides an opportunity for future research to be conducted in this area to identify factors that contributed to these outcomes.

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