Theory of planned behaviour: Higher education students' attitudes towards ICT-based learning interactions

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Phase one of a pilot study (Siragusa & Dixon, 2008) collected data from a group of undergraduate students in a higher education setting to determine their attitudes towards their engagement with ICT interactions. Phase two of the pilot study was undertaken in 2009 with another group of students in a pre-service teaching course which employed a mixed method approach. The participants completed a quantitative questionnaire, worked though an ICT-based activity and then completed a qualitative questionnaire. The questionnaire items related to components of the Theory of Planned Behaviour to determine students' attitudes and planned use of ICT-based instruction. The quantitative data indicated that students believed engaging with ICT can potentially enhance learning and plan to engage with ICT during their teaching careers. The qualitative data showed that students felt overwhelmed when commencing the activity, but felt more confident as the activity progressed. Some students suggested improvements to the learning environment.

Keywords: Information communication technologies, attitudes, planned behaviour

Background

Students in higher education are becoming increasingly exposed to information communication technology (ICT) based learning environments containing interactive learning activities which are supported with text, still images and animations. Therefore, there is an increasing need to determine how well received these sorts of interactions have been by students. To that end, the first phase of a pilot study was undertaken in 2008 with the intention of determining the applicability of the Theory of Planned Behaviour (TPB) which examined students' attitudes towards ICT-based learning and their use in their future careers (Siragusa & Dixon, 2008). The 2008 study highlighted merits of this application of the TPB and, hence, the need to continue trialling this theory with other groups of students exposed to ICT-based learning environments in order to further refine the methodology and survey instruments. This paper reports on the second phase of the pilot study involving a small case of undergraduate students (n=21) regarding their attitudes and planned intended use of ICT-based interactions. The study was carried out in semester one 2009 with a sample consisting of students who were in the final year of their undergraduate education degree at a Western Australian university. The students were asked to complete a refined questionnaire from the 2008 study which collected quantitative data aimed at eliciting their intentions to use ICT, their attitudes towards such interactions, their perceived social pressure to interact with ICT, their perceived control over their capacity to interact with ICT, their beliefs about the likely consequences of interacting with ICT, their beliefs about the expectations of others regarding the interaction and their beliefs about the various factors that potentially would either help or hinder their interaction with ICT. After the students had completed the refined questionnaire they were invited to complete a 20 minute ICT interaction activity. Upon completion of the activity the students were asked to complete another questionnaire which collected qualitative data as well as giving students an opportunity to describe their reactions to the interaction they had completed. The items in both questionnaires were designed to gather data on each of the components of the Theory of Planned Behaviour (TPB) as it pertained to ICT interaction.

Developing attitudes

Common findings in the research on attitudes and beliefs show that attitudes, beliefs and behaviours are linked. Attitudes find their roots in our beliefs and they influence our behaviour. As part of the first phase of this pilot study, Siragusa and Dixon (2008) provided a detailed account of human attitude development underpinning the theories of *reasoned action* and *planned behaviour* relevant to this study, which will not be repeated here.

Predicting behaviour of technology use

The purchase and implementation of technology-based information systems in the workplace has been a major concern to administrators in organisations seeking to improve efficiency and productivity (Legris, Ingham & Collerette, 2003). The cost of implementing these technologies is expensive and has often resulted in low success rates; this has led to the need to investigate factors relating to people's planned use of technology. Davis (1989) responded to this need by developing the Technology Acceptance Model (TAM; Figure 1) to explain perceived technology usefulness and usage intentions by taking into account social influence and cognitive processes. The TAM was an adaptation of the Theory of Reasoned Action (TRA; Figure 1) developed by Fishbein and Ajzen (1975). Although the TAM model has evolved, and is now often referred to as TAM2 (Figure 1) (Venkatesh & Davis, 2000), the *attitude toward behaviour*, *subjective norm* and *behavioural intention* components are common to both TAM and TRA models, acknowledging that attitude and subjective norms have an influence on the intention to use technology leading to their actual use of technology.

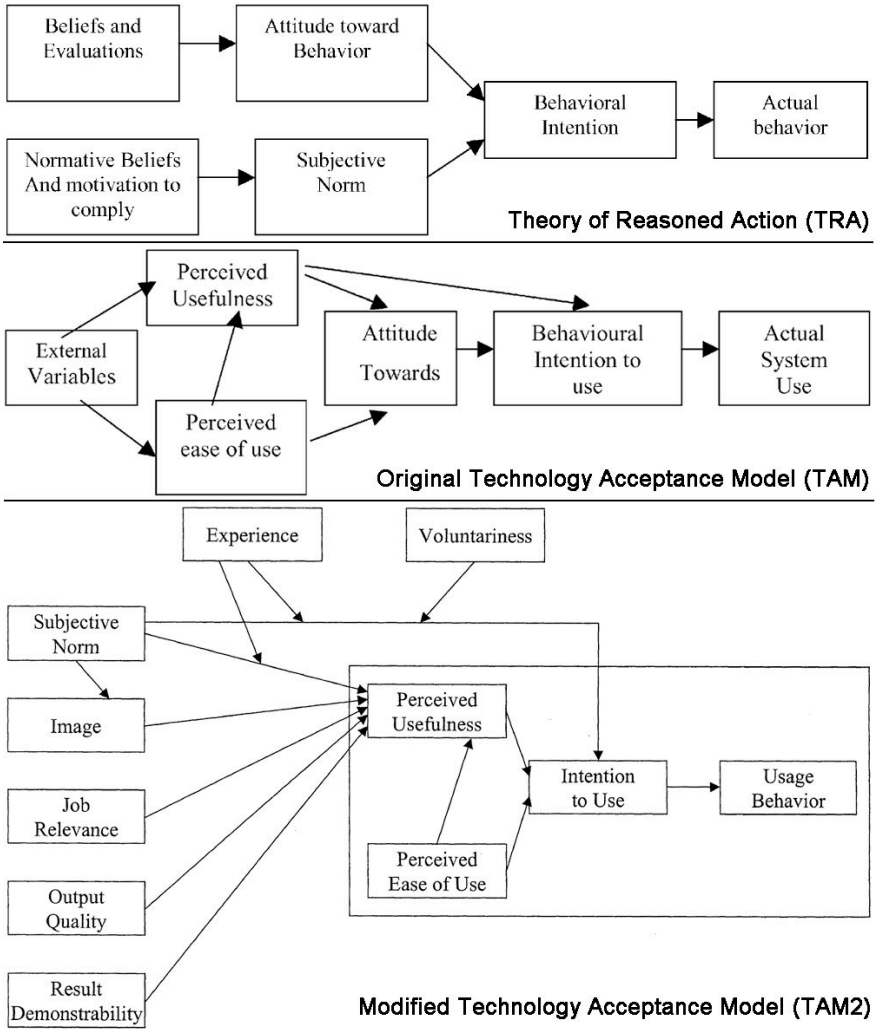

Figure 1: TRA, TAM and TAM2

The development of the Theory of Planned Behaviour (TPB; Figure 2) (Azjen, 1985), which was developed from the TRA, led researchers to consider the use of the TPB for predicting people's behaviour towards technology use. Mathieson (1991), while investigating the prediction of people's intention to use

technology, compared the TAM with the TPB. Three main differences were found: 1) TAM supposes that usefulness and ease of use are the main influences on use decisions, while TPB primarily explores beliefs that are specific to each situation and that some beliefs may generalise to other contexts and others may not, 2) Unlike TPB, the TAM is not as detailed as the TPB in determining social variables, and 3) TPB has a stronger treatment of behavioural control, whereas TAM only examines ease of use in regards to technology. Mathieson suggested that, while TAM is useful for gathering general information about people's perception of a system, TPB can provide detailed information regarding each of its components that might relate to a specific group of people.

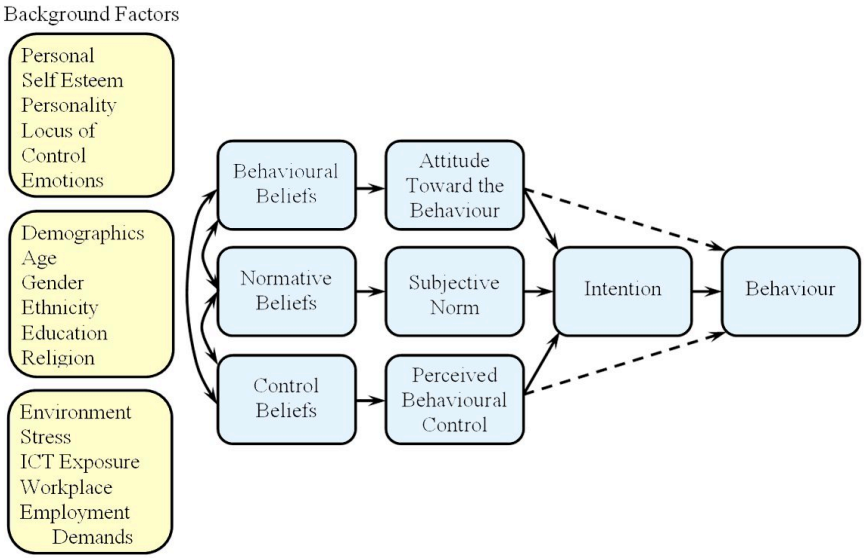

Figure 2: Theory of planned behaviour

The TRA and the TPB have continued to be employed and adapted by researchers to predict behaviour towards technology use. For example, Venkatesh and Speier (1999), by adapting measures used in the TRA and TPB, investigated how the short- and long-term effects of employee mood during new technology training influenced their motivation, intentions and usage of the new technology. Their study revealed that positive moods during training resulted in short-term increases in intrinsic motivation and intention to use the technology; however, these effects were not sustainable over a long-term. Negative moods during training resulted in decreased intrinsic motivation and intentions to use technology in the short-term and long-term, even after active use of the technology. George and Williams (2004) utilised the TPB in their investigation of planned behaviour and Internet purchasing by extending the *attitude toward behaviour* and *perceived behavioural control* components to include *Internet trustworthiness beliefs* and *unauthorised use beliefs* to determine online purchasing behaviour. Bosnjak, Tuten and Wittmann (2005) adapted the TPB to predict and explain participant numbers in a "five-wave" web-based panel study by adding a *moral obligation* component in order to obtain more detailed information about *internalized moral rules*.

This study has also adapted the TPB to predict higher education students' behaviour and attitudes towards technology-based learning. The following conceptual framework is an adaptation of the TPB developed by Fishbein and Ajzen (1980, 2010) with an emphasis on background factors. While the TAM is not explicit in this framework, elements from the TAM have been included in the development of the survey instruments.

Conceptual framework

As well as investigating people's planned use of technology, other studies conducted over the past years have utilised the TPB in an attempt to understand peoples' intentions to engage in a number of activities including weight loss, engagement with leisure activities, likelihood of committing traffic violations, willingness to vote and gift giving (Abelson et al., 1982; Ajzen & Timko, 1986; Ajzen & Driver, 1991; Hrubes et al., 2001). These studies indicate that the application of the TPB deals with the antecedents of attitudes, subjective norms, and perceived behavioural control. These antecedents determine intentions and actions. The research suggests that human action is influenced by a favourable or unfavourable evaluation of the behaviour (attitude towards the behaviour), perceived social pressure to perform the behaviour (subjective norm) and perceived capability to perform the behaviour (perceived behavioural control). In combination, attitude, subjective norm and perceived behavioural control lead to the

formation of a behavioural intention. In general, the more positive the attitude towards performing the behaviour, along with substantial levels of social pressure to do so and perceived control over one's actions, the more likely the individual is to carry out the behaviour. Often behaviours pose difficulties with regard to execution. In this way it is useful to consider perceived behavioural control in addition to intention. Depending on how realistic people are in their judgements of the level of difficulty associated with a behaviour, a measure of perceived behavioural control can serve as a proxy for actual control and as such can contribute to the prediction of the behaviour in question. When applied to the engagement with ICT, the TPB suggests that intentions to engage and interact with a particular program or software element is influenced by attitudes towards using ICT, perceived social pressure to do so and by perceptions of control over the interaction. The major components of the TPB as designed by Fishbein and Ajzen (1980, 2010) and background factors are presented in Figure 2.

Methodology

Based upon the results of the first pilot study (Siragusa & Dixon, 2008), adjustments were made to the methodology for this study, which included not filming the students while they were completing the ICT activity as this was not beneficial to the study, asking students to completing the ICT activity as a group rather than individually, and making closer alignments between the quantitative questionnaire and the qualitative questionnaire. As with the 2008 study, this study intentionally used a mixed method approach which combined the strengths of both quantitative and qualitative paradigms in order to investigate the phenomenon (Creswell, 2005). Mixed method research focuses upon 'collecting, analysing and mixing both qualitative and quantitative data in a single study or series of studies' in order to understand the problem better (Creswell & Plano Clark, 2007, p. 5). The focus of this research was to examine a convenient sample of students currently studying in the Bachelor of Education Program (n = 21).

The first part of this study involved the development and administration of a 27 item questionnaire, which was refined from the instrument used in the previous study (Siragusa & Dixon, 2008) in order to collect quantitative data. The refined questionnaire was designed to assess variables associated with the use of ICT and contained sections which were derived from components of the Theory of Planned Behaviour (see Figure 1). The items within these sections were aimed at investigating the participants' behavioural beliefs, normative beliefs, control beliefs, attitudes, subjective norm, perceived behavioural control and intentions. An initial background section was also included in order to collect information related to the students' age, their understanding of the operation of combustion engines and their perceived levels of ICT competence. The sample was also asked to respond to four items that sought to determine the value associated with ICT use in terms of its impact upon learning. The refined questionnaire served to gather baseline data on the sample's attitudes and beliefs towards the use of ICT.

Upon completion of the refined questionnaire the sample completed a 20 minute ICT-based activity. The activity was designed to teach the operation of the *Wankel rotary engine cycle*. This activity was chosen for the study due to its suitability for complete student-centred learning and included reading text, viewing still images and animations and understanding the information presented in order to complete the final task without the need for instructor intervention. When they completed the activity, the students were asked to complete a qualitative questionnaire asking then how they felt before engaging with the activity, how they felt as they progressed, how this activity could be improved and whether such activities were useful for teaching and learning.

ICT interaction design

The ICT-based interaction activity developed for this pilot study incorporated Moreno and Meyer's (2000) design principles for a learner-centred approach to understanding scientific systems including cognitive theory. Meyer (2003) posited the notion that ICT-based learning, when appropriately designed, has the potential to facilitate student learning more deeply through messages composed of words and pictures rather than through traditional means of communication involving words alone. To avoid cognitive overload, the respondents were required to read the text before viewing the animation. After having read the text, they clicked on a button to reveal the animation (see Figure 2). The participant had the option of moving the animation window to one side so that the text could also be read while the animation was playing if desired. While this approach was deemed satisfactory as the focus of this pilot study was on the theory of planned behaviour, follow up studies will include longer animation sequences with possible audio narration where appropriate as students tend to learn better when verbal information is presented as audio speech rather than visually as on-screen text (Moreno & Mayer, 2000; Mayer & Moreno, 2003).

Quantitative data analysis

A total of 21 students completed and returned the refined questionnaires and also completed the ICT interaction activity. The respondents consisted of 100% females; 20 of these respondents were between the ages of 15 and 29, while one was between the ages of 30 and 39. All of the participants indicated that they had no basic understanding of the operation of a combustion engine. The following Table 1 provides a summary of the respondents' perceived ICT competency levels.

Table 1: ICT competency levels and importance of ICT-based learning to future careers

Item	Statement	1	2	3	4	5	6	7	pol.	mean	s.d.	cor.
	ICT Competence											
Q3	Please indicate your level of ICT competence			14%	43%	33%	5%	5%	+	4.43	0.95	1.00

(N=21. 1 = Extremely low; 7 = Extremely high)

A scale analysis of the dimensions used in the student questionnaire is presented in Table 2. With each of the dimensions, seven-point bipolar adjective scales (1 = extremely high, 4 = uncertain or indifferent, 7 = extremely low) were used to assess the participants' perceptions of the item statements presented in the questionnaire. Table 2 also reports the mean (the calculated average of the mean scores for each item within each scale), mode and median scores for each of the scales. Tables 3 through to 7 displays the statements and response rates for each item. For the purposes of this study, the analysis is based upon item-by-item rather than scale analysis.

Table 2: Scale mean, mode, median and standard deviation from initial student questionnaire analysis

Scale	No. of items	Range of items means		Summary Statistics					
		Lowest item mean	Highest item mean	Mean	Mode	Median	S.D.	Kurtosis	Skewness
Background Factors – Values	4	4.00	7.00	5.77	6.00	6.00	0.91	-0.79	-0.31
Theory of planned behaviour									
Behavioural Beliefs	6	2.67	7.00	4.74	4.50	4.67	0.99	0.66	0.30
Normative Beliefs	2	1.00	7.00	4.90	6.50	5.50	1.72	-0.43	-0.63
Control Beliefs	4	3.25	7.00	5.07	5.00	5.00	0.98	-0.14	0.23
Attitude Towards Behaviour	2	3.50	7.00	5.12	5.00	5.00	0.93	-0.63	0.18
Subjective Norm	2	2.50	7.00	5.19	4.00	5.50	1.27	-0.82	-0.27
Perceived Behavioural Control	2	1.50	7.00	4.76	6.00	5.00	1.39	-0.19	-0.50
Intention	2	3.50	7.00	5.48	6.00	5.50	1.09	-0.94	-0.13
Student n=21									

The following presents the response percentages for the questionnaire items. Items 13, 14, 17 and 22 have been negatively polarised. That is to say, the negatively polarised scores have been reversed so that they are scored and displayed as positive statements. Reverse scoring has been done for all 7-point bipolar adjective questions in the questionnaire which are interpreted as being negative statements about their perception of ICT interactions. For example, item 13 is worded as a negative statement "Engaging with ICT makes me feel angry". However, as it is reversed-scored, the mean score of 4.38 indicates that more participants disagreed with this statement from those which agreed.

Intentions, attitudes, subjective norms and perceived behavioural control

The response rates to the Intentions, Attitudes, Subjective Norms and Perceived Behavioural Control scales are shown in Table 3. Approximately three quarters of the participants indicated that they intend to engage in regular ICT use (76% – the sum of 5, 6 and 7 responses), while 72% intent to embed ICT to assist their teaching activities on a regular basis. Half of the respondents (53%) indicated that interacting with ICT is pleasant and three quarters (76%) thought that interacting with ICT is helpful. A total of 77% respondents indicated that people who are important to them believe that ICT skills are essential, while 62% believed that people important to them think they should engage in ICT. A further 62% thought that engaging with ICT is easy and that they could interact successfully with ICT at all levels.

Table 3: Intentions, attitudes, subjective norms and perceived behavioural control

Item	Statement	1	2	3	4	5	6	7	pol.	mean	s.d.	cor.
	Intentions											
Q4	In the future I intend to engage in regular ICT use				24%	14%	43%	19%	+	5.57	1.05	0.70
Q5	I intent to embed ICT use to assist my teaching activities on a regular basis			5%	24%	29%	14%	29%	+	5.38	1.25	0.70
	Attitudes											
Q6	Interacting with ICT is pleasant			5%	43%	29%	19%	5%	+	4.76	0.97	0.62
Q7	Interacting with ICT is helpful				24%	24%	33%	19%	+	5.48	1.05	0.62
	Subjective Norms											
Q8	People who are important to me think that I should engage with ICT	5%	5%	10%	19%	19%	29%	14%	+	4.86	1.61	0.66
Q9	Most people who are important to me believe that ICT skills are essential				24%	24%	29%	24%	+	5.52	1.10	0.66
	Perceived Behavioural Control											
Q10	I rate the difficulty of engaging with ICT extremely difficult/ extremely easy		5%	24%	10%	24%	33%	5%	+	4.71	1.39	0.70
Q11	If I want to I can interact successfully with ICT at all levels	5%	5%	10%	19%	19%	33%	10%	+	4.81	1.56	0.70

(N=21. 1 = Extremely unlikely; 7 = Extremely likely)

Behavioural beliefs, normative beliefs and control beliefs

Table 4 displays the response rates to the Behavioural Beliefs, Normative Beliefs and Control Beliefs scales. The majority (86%) believed that engaging with ICT gave them a sense of competence and achievement, while only half (53%) felt that engaging with ICT gave them a sense of control. Approximately one third of the participants agreed that engaging with ICT makes them feel angry (29%), frustrated (34%) or apprehensive (15%). Over half indicated that their friends (58%) and family (57%) encourage them to engage in ICT. The majority thought that they had ICT skill levels appropriate to the demands of teaching (80%), have the knowledge to engage in successful ICT use (96%) and are keen to engage in ICT use (71%). More than one third, however, agreed that it takes them a great deal of effort to engage in ICT use (38%).

Table 4: Normative Beliefs and Control Beliefs

Item	Statement	1	2	3	4	5	6	7	pol.	mean	s.d.	cor.
	Behavioural Beliefs											
Q12	Engaging with ICT makes me feel a sense of competence		5%	10%	10%	29%	33%	14%	+	5.19	1.33	0.69
Q13	Engaging with ICT makes me feel angry	5%	29%	10%	29%	19%	5%	5%	-	4.38	1.53	0.63
Q14	Engaging with ICT makes me feel frustrated	5%	14%	14%	33%	24%		10%	-	4.05	1.50	0.64
Q15	Engaging with ICT makes me feel a sense of achievement			10%	5%	43%	24%	19%	+	5.38	1.13	0.48
Q16	Engaging with ICT makes me feel a sense of as though I am in control			14%	33%	19%	24%	10%	+	4.81	1.22	0.53
Q17	Engaging with ICT makes me feel apprehensive	5%	24%	24%	33%	5%	10%		-	4.62	1.29	0.50
	Normative Beliefs											
Q18	My friends encourage me to engage in ICT use	5%	5%	5%	29%	10%	19%	29%	+	5.05	1.73	0.90
Q19	My family encourage me to engage in ICT use	5%	5%	19%	14%	10%	33%	14%	+	4.76	1.72	0.90
	Control Beliefs											
Q20	How likely is it that your ICT skill level is appropriate to the demands of teaching?		5%	14%		14%	52%	14%	+	5.38	1.40	0.32
Q21	How likely is it that you have the knowledge to engage in successful ICT use?			5%		48%	38%	10%	+	5.48	0.85	0.72
Q22	How likely is it that it takes a great deal of effort for you to engage in ICT use?	10%	19%	10%	24%	24%	14%		-	4.24	1.57	0.45
Q23	How likely is it that you are keen to engage in ICT use?		5%	5%	19%	24%	33%	14%	+	5.19	1.30	0.70

(N=21. 1 = Extremely unlikely; 7 = Extremely likely)

Background factors: Values

The response rates to the respondents' perception of values are shown in Table 5. Their responses were quite positive with regards to engagement with ICT enhancing learning (90%) and being essential for good education (86%), high ICT skill levels making learning easier (76%) and effective use of ICT being essential in the workplace (95%).

Multiple choice activity

Upon completion of the ICT interaction activity, the respondents were asked to complete a multiple choice activity to help determine whether they understood the essential concepts taught in this activity.

The results, presented in Table 6, indicate that the majority made correct choices for items 1, 2, 4 and 5, while only just over half (57%) made the correct choice for item 3 (which may indicate a problem with the wording of this item).

Table 5: Background factors: Values

Item	Statement	1	2	3	4	5	6	7	pol.	mean	s.d.	cor.
	Background Factors - Values											
Q24	Engagement with ICT enhances learning				10%	19%	38%	33%	+	5.95	0.95	0.76
Q25	Engagement with ICT is essential for a good education				14%	29%	24%	33%	+	5.76	1.06	0.85
Q26	High level ICT skills make learning easier			5%	19%	24%	33%	19%	+	5.43	1.14	0.75
Q27	Effective use of ICT is essential in the workplace				5%	29%	33%	33%	+	5.95	0.90	0.75

(N=21. 1 = Definitely no; 7 = Definitely yes)

Table 6 Multiple-choice activity

Item	Multiple Choice Question	1	2	3	4	5	Difficulty	Discrimination
Q1	Which is the correct sequence of the Wankel rotary engine cycle?		100%				1.00	0.00
Q2	As the rotor continues to rotate after the Intake phase of the cycle, the fuel starts to compress because the...		5%	95%			0.95	0.12
Q3	During combustion, after the spark plug has ignited the fuel creating pressure which moves the rotor, the...	14%	14%	14%	57%		0.57	- 0.24
Q4	The combustion gases as free to flow out of the chamber because the...	90%	5%	5%			0.90	0.21
Q5	Which phase of the Wankel rotary engine cycle is occurring at the location of the blue arrow.		5%	86%	10%		0.86	0.07

(N=21. 1 = Definitely no; 7 = Definitely yes)

Quantitative analysis summary

The quantitative analysis examined the responses to the seven-point bipolar adjective scales items in the questionnaire regarding Intentions, Attitudes, Subjective Norms, Perceived Behavioural Control, Behavioural Beliefs, Normative Beliefs, Control Beliefs and Background Factors. Overall, the responses were quite positive and ranged from very positive responses to the Background items through to less positive responses to the Normative Beliefs items. While these results were similar to those obtained from the 2008 pilot study (Siragusa & Dixon, 2008), the refinement of the questionnaire for this study provided data that was better aligned with the components of the Theory of Planned Behaviour and relevant aspects of students' attitudes towards ICT-based interactions.

Qualitative data analysis

Upon completion of the quantitative questionnaire, the 21 participants then worked through the 20 minute self-paced ICT-based activity (see Figure 3) which included reading text with still images, viewing animation sequences and multiple-choice questions (see Table 6). Before they commenced the activity, the sample was given a brief introduction and explanation of the process. Upon completion of the ICT-based activity, the participants were then asked to complete a 10 item questionnaire in order to collect qualitative data in the form of short written answers to open-ended questions. The 10 item questionnaire asked questions relating to their attitudes towards interactive ICT-based learning based upon the components of the Theory of Planned Behaviour, their perception of the importance of ICT-based learning in teaching and learning and issues relating to the instructional design of the learning activity they had completed. The samples' responses were examined through a content analysis which is presented below.

Attitudes towards the interactive ICT learning activity

All of the participants responded somewhat negatively to the question of how they felt when they first sat down to do the activity. Their responses included feeling nervous, apprehensive, confused, worried and overwhelmed. Their reactions may have been due to the fact that the subject matter was unfamiliar to them and the use of ICT-based learning activities was not utilised in any part of their course. The respondents were then asked to indicate if their attitude towards the activity changed in the first few minutes of interaction. The majority (86%) indicated that, as they worked their way through the activity including reading the text and viewing the still images and animations, they began to feel more comfortable with the activity; the rest of the respondents still felt somewhat overwhelmed and uncomfortable with doing this activity.

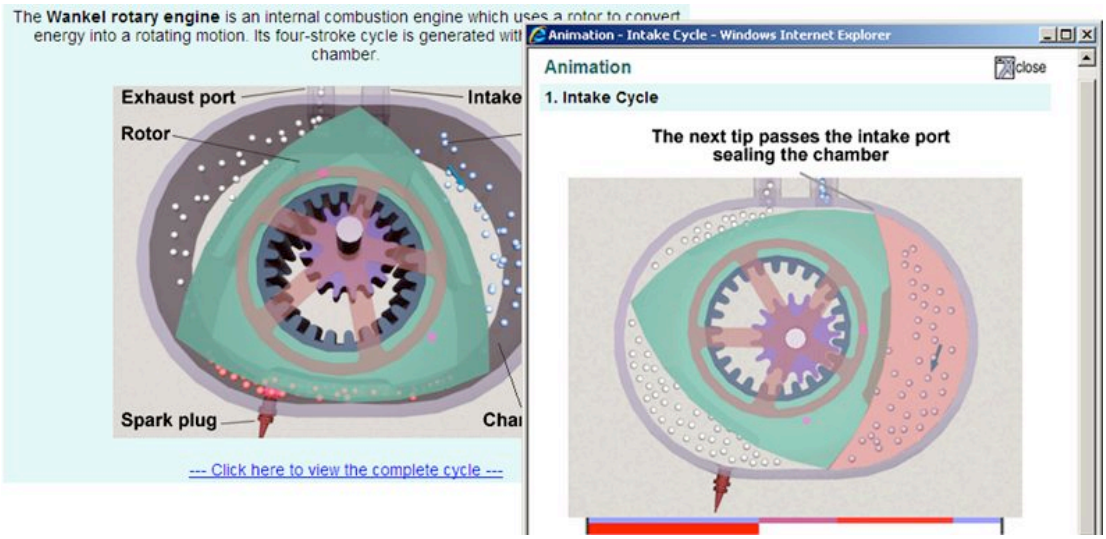

Figure 3: Screen capture of components of the ICT interaction activity

> I felt confused as this is something new to me. I do not have any basic knowledge of rotary engine cycles… When I realised what the activity was and its purpose, my attitude changed positively, and I was more willing to participate… I started to feel more at ease as I started reading and viewing the animations because I started to understand the information.

The participants were asked if they were aware of how their peers around them were reacting to the program and to describe what impact this had on them. While nearly half (48%) were not aware of how their peers were reacting, seven (33%) were having difficulties with the questions and noticed that others were also struggling, overwhelmed and/or confused (four of these were relieved to see others struggling). Two (10%) of the respondents were wondering how the others were coping with the activity and two noticed some others interacting and asking each other questions

> I was not really aware of others reactions as I was trying to concentrate.

> I guess we were all a bit unsure so started by referring to what each other were doing, which made it easier in the beginning but as the activity went on I found I didn't need to rely on them.

> I think they felt overwhelming and unsure. I felt like they were in the same boat as me, reacting in a similar way.

The respondents were asked to describe their feelings of control over what they were doing during their interaction with the activity. Eleven (52%) respondents indicated that they definitely had control of their learning with this activity, some of which specifically stated that they had the ability to move between screens, view the animations as many times as needed and work at their own pace.

> A lot more control compared with having images on paper… it gave many options to explain the cycle and I used the one that worked best for me … I felt in control as I could watch the animation as often as I wanted and work at my own pace ... I could choose to watch the animation when I wanted to rather than it being distracting on the main page.

> I felt very much in control, especially because I could view/read info as many times as necessary until I felt I understood it. This meant I didn't feel nervous or under time constraints.

One participant felt as though she had no control, while nine others (43%) felt that they had little to no control in the beginning, but their feelings of control grew as they progressed through the activity.

> At first I felt somewhat out of control as I watched the animation first. However, after discovering the text and reading the information I began to feel more confident.

The respondents were asked to identify adjectives that would accurately describe how they felt while they were interacting with the activity. Four (19%) of the respondents felt rather positive when interacting with the activity, while another five (24%) respondents indicated negative feelings. Positive feelings were described as being amazed, relaxed and confident, while negative responses indicated a level of apprehension and a general feeling of being overwhelmed.

Twelve (57%) of the participants used adjectives that suggested they started the activity with somewhat negative feelings (nervous, confused, apprehensive, frustrated), but as they worked through the activity they began to feel more positive (relaxed, relieved, happy, confident, pride, intelligent).

Importance of interactive ICT in teaching and learning

When the participants were asked how important they believed high level ICT skills are in regards to being a good teacher, they all indicated that it is important at varying degrees. Nearly half of the respondents (48%) believed that high level ICT skills are very important, 43% believed them to be important and 9% indicated that they are moderately important.

> I think they are very important because technology is a very large part of children's lives today. In order to help students learn effectively, teachers need to be able to help students use ICT.
>
> I think they are very important. With the amount of information about computers that I have taught myself or been taught by siblings I realised that more work on computers when I was at school could have really helped. I realised that there is a lot that I don't know and do not want my students to feel the same way.
>
> I think they are important to not only be a good teacher but to function effectively in society. Children need to be exposed to ICT as it is a part of their daily lives and experiences. To teach well I must be able to demonstrate a positive attitude towards technology and provide interesting and motivating experiences for children.
>
> Being a good teacher, I think, does not depend on how good your ICT skills are, because I feel many experienced teachers (that are a bit older!) are great because of what they have been through in their teaching career but are not necessarily really good with ICT. In saying that though, high level ICT skills may be a factor in being a good teacher.

The participants were asked to indicate the importance of the role ICT activities play in the overall process of teaching and learning. They all believed, at varying degrees that ICT activities should be a component within their early childhood teaching and learning context. One third (33%) indicated that ICT activities are very important, 48% believed that they are important and 19% thought they are moderately important.

> Very important, it catered for visual & linguistic learners … it provides a far more visual method of understanding concepts and processes … allows more interactive learning which children respond well to.
>
> Being an early childhood teacher I could see that activities such as this would be beneficial to children in a simpler form, however I don't know how often I would actually use them. They are important however as the world children live in is becoming ever-increasingly technological.
>
> I think it is important to provide students with the opportunity to use ICT as this may strongly correspond with their learning style. I think students who are strongly motivated and have the ability to regulate their own learning would find these activities useful.
>
> I think it should play a part, but not a huge one. You can't solely rely on ICT activities in the classroom, as authentic play is more important in early childhood. Not all students may enjoy or be good with technology as well and they need to be catered for. It is important to include it, but it cannot be the only way to learn.

Issues relating to instructional design

The respondents were asked questions relating to the instructional design of the learning activity. When asked what parts of the activity worked for them and which parts did not with regard to helping them

understand the engine cycle, 67% indicated that the animations helped with understanding the concept, while 19% of these respondents felt that the text did not help.

> The step by step explanation certainly worked well. Just reading the text without the cycle would not work for me. The animation does a better job in explanation.

However, 10% indicated that they preferred reading the text and found the images difficult to understand. A further 14% of the respondents needed to understand the context in which the engine fits into.

> The describing paragraphs worked well because they consisted of language appropriate to my own development. The diagrams didn't work too well because I found them confronting and I got lost in trying to understand them.

> I think it might be good to tells us where this engine comes from, that way we could understand the cycle better.

The participants were also asked to indicate whether the text, still images and/or the animations impacted more on their understanding of the rotary engine cycle. Nearly half (48%) suggested that animations assisted with their understanding, 24% described how the combination of text and animations helped, and a further 10% indicated that the combination of text, still images and animation contributed to their understanding. Only one participant depended on text and still images, and one other relied on animation and still images.

> Definitely animation, because it brings me through the process of what happened first, then next and the cycle goes on, helping me to understand about the Rotary engine more.

> The still text and the animation because the text explained the process and then the animation helped me make connections.

Another 10% found the text alone more useful, particularly for assisting with answering the questions.

> The still text because it consisted of language appropriate to my own development, and I could find the words used in the questions in the text, thus it was easy to answer the questions.

When asked how could the text, still images and/or the animations be improved to enhance the instruction, 24% of the sample suggested altering the text format to further break up the information into smaller components and to simplify the language and 24% indicated the need for more detailed text to accompany the animations and to alter the layout of the information such as including all the stages of the cycle in one picture. A further 10% of the participants suggested including a voice-over with the animation which could explain the engine cycle in more detail. One respondent suggested including more animations.

> A way to improve the text might be to simplify the language at first and then introduce more detailed language. A way to improve the still images would be to have the information pop-up when you hover over different sections of it with your mouse.

> The information provided on the animations could be placed in a position that's easier to read while watching animation (i.e., bottom of animation). Other than that, it worked well.

> The still image could be shown again at the end with all four parts of the cycle labelled, similar to the first image but with the processes labelled rather than the parts of the machine.

Qualitative analysis summary

The majority of the participants responded positively to the 10 item questionnaire. Most of the sample had expressed feelings of anxiety when they started the ICT-based activity and some were overwhelmed and confused, but as they progressed the majority felt relieved and did not find the interaction as difficult as they initially thought it would be. A small number of the sample were clearly uncomfortable throughout the entire process which might be attributed to the fact that they were totally unfamiliar with the topic of combustion engines as well as having little or no exposure to similar ICT-based learning environments. They all believed that the use of interactive ICT-based learning has some place in the teaching and learning process. They all agreed that the students they would be teaching in the future need to have exposure to similar interactions as they are growing up into a world of technological advancements. Some

of the participants suggested that these ICT-based learning environments also have the potential to cater for various learning styles including visual learners and text-based learners. At the same time, however, some of the sample made the point that these types of interactive environments should not be a complete replacement for good teaching practices, particularly in the early childhood years. The participants also made several suggestions for the ICT-based activity they had completed including providing more text with the animations to cater for text-based learners.

Conclusion

One of the aims of this second pilot study was to make a stronger connection between the quantitative and qualitative survey instruments, which has provided more useful data for analysis. As with the first phase of this pilot study (Siragusa & Dixon, 2008), this second phase of the pilot study has also revealed the usefulness of the application of the Theory of Planned Behaviour for providing insights into the attitudes of students in an undergraduate higher education program towards their engagement and intended use of ICT-based learning. The quantitative data that was collected suggests that the participants felt that interacting with ICT is pleasant and helpful and that it also gave them a sense of control and achievement. The vast majority of the students indicated that engaging with ICT was easy and that it gave them a sense of confidence. Interestingly, the qualitative data indicated that when the participants first approached the ICT-based learning activity, the majority felt overwhelmed and anxious and some lacked confidence in being able to complete the activity. The students had little or no prior knowledge of the topic they were required to learn and they were not accustomed to learning new concepts through such ICT-based learning activities. This could have contributed towards their initial lack of confidence and levels of anxiety. Their confidence, however, improved as they progressed through the activity, and this could possibly be attributed to the design of the interaction and the level of difficulty of the multiple choice questions at the end. The quantitative and qualitative data both suggested the participants agree that, when designed and used appropriately, engaging with ICT enhances learning and the importance of its role in teaching and learning is high. Further investigation into the relationships between students' attitudes towards ICT, their intentions to use ICT in their future careers and their actual engagement will most likely reveal valuable insights into the design and implementation of ICT interaction for learning.

Both phases of this pilot study have provided useful baseline data in regards to the application of the Theory of Planned Behaviour in order to determine students' attitudes and intended use of ICT-based learning. The continuation of this research will involve ongoing refinement of the survey instruments in order to increase their reliability and reduce internal inconsistencies. The next phase will continue to collect both quantitative and qualitative data which will lead to further insights into the relationships between the variables within the framework which have an influence on higher education students' behaviour and attitudes towards ICT-based learning.

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