

**Science and Mathematics Education Centre**

**THE DEVELOPMENT AND APPLICATION OF AN EDUCATIONAL  
TECHNOLOGY ACCEPTANCE MODEL**

**Dobriła Lopez**

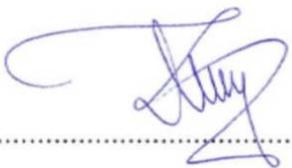
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Doctor of Philosophy  
of  
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## Declaration

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## **ABSTRACT**

This research developed and implemented the educational technology acceptance model ETAM. The model was developed to investigate the attitude towards technology acceptance in educational settings. It is evolutionary in its nature and combines the two well-known instruments, the Technology Acceptance Model (TAM) and the What Is Happening In this Classroom (WIHIC) to make a new educational technology acceptance model. This model incorporated all the WIHIC scales (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity) and two TAM scales (Perceived Usefulness and Perceived Ease of Use). It also includes four demographic elements: Age, Gender, Prior Experience and English as a first language.

The central proposition of the ETAM is that environmental factors are an important consideration in the evaluation of software acceptance. To evaluate this model, student and lecturer attitudes towards a specific software package, Salsa, were studied. The context of the study was the use of educational software in ten computing classes in tertiary programmes of study in a large metropolitan polytechnic in Auckland, New Zealand. Both lecturer and student perceptions were investigated.

To gather lecturer perceptions, semi-structured interviews were carried out with the lecturers teaching the courses. The semi-structured interviews were analysed qualitatively and thematic analysis was used. To gather student perceptions, a purpose-written questionnaire was developed. The student perspective was analysed quantitatively. A total of 208 student responses were collected. The analysis involved formal statistical testing of a number of hypotheses.

To determine the unique contributions of each component, path analysis and multiple regressions were used. The major findings were that all the WIHIC constructs have a positive correlation with Perceived Usefulness and Perceived Ease of Use. The unique contributions of each of the WIHIC constructs in the ETAM model were identified. The two major contributors were: Task Orientation and Studying. Task Orientation explained 15% of the variance in the Perceived

Usefulness and 11% of the variance in Perceived Ease of Use. This is a significant and a unique contribution of this study to identify that Task Orientation and Studying are major predictors in technology acceptance. This finding informs practitioners and allows them to use a shorter version of the questionnaire while still capturing the main influences of technology acceptance in the classroom.

The main result of this study was a new model for technology acceptance the Educational Technology Acceptance Model (ETAM) designed for educational environments. The results of this study add to the body of knowledge of technology acceptance model (TAM) applications in educational settings. The study also adds new knowledge to the better understanding of educational environment constructs. The results of the study could benefit students by collecting information that helps them to make decisions on the future use of the software tool, and informs course designers in tertiary institutions about the usefulness of the technology and students' attitudes towards technology acceptance. The results helps other practitioners make informed decisions on whether to offer the tool to students and how to get the best use from the tool, if used. The study adds to the body of knowledge around the interaction between technology and the classroom environment. It adds to the body of knowledge by gaining a better understanding of attitudes toward software acceptance in an educational setting.

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## Chapter 1.

### **INTRODUCTION**

Information technology has become an integrated part of our everyday lives. It is in every place; in our schools, hospitals, workplaces and entertainment. It makes our lives richer and gives us endless possibilities to create and learn. The evolution and application of information technology has been investigated over many decades and as a result many new areas of research emerged. Particular attention, in this thesis, has been given to research of the classroom environment influences on students' achievement, and user technology acceptance research. Both of these areas produced many different instruments used in the investigations. The investigation of technology acceptance started with Davis (1986) and his TAM model and continued with many other studies that followed. The incorporation of two models, the technology acceptance model TAM, and the classroom environment instrument, the WIHIC (Fraser, Fisher, & McRobbie, 1996), presented a basis for a new model designed and implemented in this thesis, the Educational Technology Acceptance Model (ETAM). This new model was developed to investigate the influence of educational environment on technology acceptance. The development and application of this model is the subject of this study.

This Chapter is organized as follows: it describes the background of the study in Section 1.2, followed by the objectives of the study and its significance in Section 1.3. The description of the study is presented in Section 1.4. The chapter finishes with an overview of the thesis.

#### **1.1. BACKGROUND**

In order to understand information technology adoption and usage, researchers developed different models over last few decades. The focus in this thesis is on the *Technology Acceptance Model* (TAM) which is grounded in psychological motivational theory. One type of research developed intention-based models which

were focused on identifying the determinants of the intention (social influences, attitudes and facilitating conditions). The Technology Acceptance Model (TAM), developed by Davis (1989), was based on the theory of reasoned action and is considered to be a special case of that theory. The Technology Acceptance Model is used to explain how readily the user accepts the technology. The result of this research informed software designers and directly influenced software design. It also impacted indirectly on a usage of that software and the technology in a specific environment. Investigations of attitudes toward software use with the Technology Acceptance Model helped the software designers to better understand the user and their interaction with the software. This better understanding of user attitude resulted in better understanding of ways to improve the software in order to align it with the users' preferences. Ultimately, all this resulted in a better understanding of technology usage in an organization. So it is assumed that better understanding of usage informs and improves the design of the technology and therefore influences the acceptance or rejection of that technology. The technology acceptance model TAM has been used in this study to investigate technology acceptance in the educational environment.

An overview of the literature has indicated that the use of the TAM has been mainly limited to the business environment. In most of the studies presented, students were used to simulate professional use, but the use of educational software by students was not fully studied. Where educational software was studied, the focus was on online and e-learning, new technologies (mobile), and new media. Most used either the original TAM model or the UTAUT model in the investigations with the addition of many new constructs: social ability, readiness, enjoyment, computer efficacy, self-efficacy, trust, confidence, facilitating conditions, etc. This review showed that there is a lack of systematic investigations into the effects of environmental factors on technology acceptance by students or teachers.

Many authors (Askar & Umay, 2001; Bagozzi, Davis, & Warshaw, 1992; Huang & Liaw, 2005; Myers & Halpin, 2002; Rovai & Childress, 2002; Yildirim, 2000) investigated different aspects of the technology used in the classroom environment and included some of the constructs but not all. This gap is addressed in this thesis

by incorporating all of the constructs of the WIHIC questionnaire which addresses all relevant constructs for the study of classroom learning environment. The objective of this study was to increase the knowledge and understanding of the factors that influence technology acceptance in the classroom environment. No study so far has fully investigated technology acceptance in the educational environment with the WIHIC educational environment questionnaire. The WIHIC instrument has been used and validated in many studies (Aldridge & Fraser, 2003; Chang & Fisher, 2003; Chard, 2010; Dorman & Fraser, 2009; Kanokporn & Fisher, 2008; Khine & Fisher, 2003; Koul, Fisher, & Shaw, 2010; She & Fisher, 2003; Skelton, 2010; Snell & Snell-Siddle, 2010; Tobin, 1998). It is regarded as the most comprehensive instrument to investigate the impact of the classroom environment on learning and teaching.

The ETAM instrument, used to capture the student perspective of technology acceptance, was derived from two sources. The first was the original technology acceptance model TAM developed by Davis (1986) with two basic constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PEU). The second was the What Is Happening In this Class (WIHIC) questionnaire with seven environmental constructs: Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. These constructs were integrated into the TAM model producing a tailored questionnaire. In addition four demographic constructs were incorporated: age, gender, experience prior to study, and English as first language or not. The WIHIC was chosen as being the most comprehensive and widely-used instrument for the investigation of student perceptions of their educational environment.

The lecturer perceptions of technology acceptance were investigated with a qualitative method. The instrument used comprised semi-structural interviews. These attempted to capture the lecturers' perceptions of technology acceptance in their classroom. Perceived Usefulness and Perceived Ease of Use were investigated in the interviews. The study by Dorman and Fraser (2009) suggested that teacher attitude had a strong effect on students' attitude; therefore teacher attitude and perceptions were investigated. The interviews were used as an instrument that can

capture a richness of information and can accommodate for the small number of participants accordingly.

## **1.2. DESCRIPTION OF THIS STUDY**

The context of the study included the use of educational software in computing classes in tertiary programmes of study in a large metropolitan polytechnic in Auckland, New Zealand. Both lecturer and student perceptions were investigated. It involved ten classes of students in hardware, information systems and programming courses over two semesters.

Students and lecturers were implementing Salsa software, used to manage students learning. This software was used to evaluate the ETAM model designed to investigate students' acceptance of the technology. The central proposition of the ETAM model was that environmental factors are an important consideration in the evaluation of software acceptance. To evaluate this model, student and lecturer attitudes towards a specific software package, Salsa, were studied. The analysis of the lecturers' perception was performed qualitatively. The analysis of students' perception was performed quantitatively.

The ETAM model was designed with the two major groups of constructs incorporating the Perceived Usefulness and Perceived Ease of Use constructs from TAM, and to the seven constructs from WIHIC: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness. In addition the study investigated the influence on technology acceptance of age, gender, prior experience and English as a first language.

## **1.3. OBJECTIVE AND SIGNIFICANCE**

The literature suggests that student perceptions of classroom environment powerfully influence their approach to learning (Booth, 1997, p.205). It is established that a positive environment enhances student achievement and

attitudes (Fisher, Henderson, & Fraser, 1995; Goh, Young, & Fraser, 1995; Wubbels & Levy, 1993). Past research has confirmed the importance of teachers' contributions toward creating positive learning environments particularly through their interaction or communication with students (She & Fisher, 2000, 2002). Accordingly the technology that is placed in this environment should be affected by this environment. This study investigated the influence of the educational environment on the technology acceptance.

This is the first study of attitudes toward technology acceptance in the classroom environment of a tertiary institution. It was focused on investigating the effect of an educational environment on attitudes toward technology acceptance. The researcher designed and implemented a new model – the Educational Technology Acceptance Model (ETAM) in this investigation. This is the first technology acceptance model designed specifically for a classroom environment. This model was validated with Salsa software.

This investigation into the software acceptance within an educational environment will add to knowledge in two ways. First, it will increase the understanding of the influences of the environment on technology acceptance, and secondly it will increase the understanding of the technology acceptance by identifying which of these influences are the most important. The specific influences of such an environment on technology acceptance constructs will lead to a better understanding of the environment and the technology used within it. So the key objectives of this study were:

- To investigate the influences of the educational environment on technology acceptance.
- To identify the main predictors for technology acceptance.
- To develop and implement a tool to identify these predictors.
- To evaluate the effectiveness of the ETAM model from students' and lecturers' perspectives.

The investigation into attitudes toward technology acceptance in an educational environment that uses the Salsa software and how it is perceived by students and

lecturers provided for the identification of the positive and negative influences of the environment on technology acceptance, and the evaluation of the ETAM tool used in the investigation.

#### **1.4. OVERVIEW OF THE THESIS**

The remainder of this thesis is organised as follows: Chapters 2, 3 and 4 explain the conceptual framework of a proposed new ETAM model. Chapters 5, 6 validate the ETAM model with the use of Salsa software.

Chapter 2 reviews criteria for software acceptance. It introduces the Technology Acceptance Model (TAM) as a framework for understanding user acceptance. It includes a critical review of relevant literature. It explains the main motivational theories and major technology acceptance model and it reviews the use of the technology acceptance model in education. It justifies the need for the investigation described in this study.

Chapter 3 explores environmental influences. It describes the historical development of educational research and some of the educational tools used. The instrument “What Is Happening In Your Class” (WIHIC) is explored in some detail. A review of the use of the WIHIC instrument in different studies is described. The technology rich environment studies are explored and reviewed. The relevance of the reviews to this study is described.

Chapter 4 explains the concept of the technology acceptance model developed specifically for educational environment research. A new model of TAM is proposed. The model combines the technology acceptance model TAM and WIHIC instrument to make the new Educational Technology Acceptance Model (ETAM). This new model is specifically tailored to investigate classroom influences on technology acceptance. Chapter 4 also outlines the hypothesis of the project. The methodology section addresses the instruments, sample and qualitative and quantitative methods used in the study. It also explains the Salsa software used to validate the ETAM model.

Chapter 5 analyses the lecturers' perspectives. It is hypothesised that lecturers' views and attitudes may have an influence on the acceptance by students of the software. The lecturer perspective is captured by semi structured interviews. The sample, the instrument and the method are described. A discussion of the strengths and weaknesses of the ETAM model as an analytical framework for content analysis is included.

Chapter 6 investigates the student perspective. A purpose built questionnaire is used as the research instrument. This incorporates questions based on the TAM and the WIHIC. It explains the sample, the instrument and methodology. It describes the screening of data process and uses the measurement hypothesis. The analysis uses the first order of correlation and path analysis. The path analysis identified the unique contributions of the constructs while controlling for the others. Responses are analysed quantitatively and interactions are explored.

Chapter 7 presents conclusions. It starts with the description of the summary of the thesis chapters. It presents the findings of the study and describes its significance. It comments on the limitations of the study and suggests directions for future research. It finishes with the concluding remarks.

## Chapter 2.

### **CRITERIA FOR SOFTWARE ACCEPTANCE**

In order to understand criteria for information technology adoption and usage researchers have been developing different models over last few decades. The focus in this chapter is on the *Technology Acceptance Model* (TAM) introduced by Davis (1989) and on its subsequent refinement and enhancement.

The evolution and application of new technology has been investigated over many decades and as a result many new research areas have emerged. Particularly important areas for this study were: the research of associations between classroom environment and student outcomes, and user technology acceptance research. Both of these areas produced many different instruments used in the investigations. In the investigation of classroom environment one of the most robust and most used instrument is the WIHIC (Fraser, Fisher, & McRobbie, 1996). Investigations in technology acceptance started with the technology acceptance model TAM by Davis (1986), and many other studies then followed. The amalgamation of these two instruments presented a base for a new model, designed and implemented in this thesis. There are two reasons for combining the TAM and WIHIC. First, both of these instruments are generic and can be used for any setting, technology, or user types. Second, both of these instruments have antecedents in motivational theory and, as such, were logical choices to be combined.

This new model was developed to investigate the influence of the educational environment on technology acceptance. The development and application of this model is the subject of this study.

This Chapter starts with a description of the technology acceptance instruments and investigations which used these instruments. Section 2.1 explores the motivational theories including: Trait theory, Social Cognitive theory, the Theory of Reasoned Action and the Theory of Trying. Section 2.2 describes the Technology Acceptance Model including: the TAM, TAM2, TAM3, and the Unified Theory of

Acceptance and Use of the Technology (UTAUT). Section 2.3 presents applications and validations of TAM and Section 2.4 describes the use of the TAM in educational environments and highlights the need for a specialised technology acceptance model within the educational environment. A chapter summary is presented in Section 2.5.

## 2.1. MOTIVATIONAL THEORIES

The technology acceptance model is grounded in psychological motivational theory. One type of research developed intention-based models which were focused on identifying the determinants of the intention: social influences, attitudes and facilitating conditions.

The most widely known motivational models are the *psychology attitude paradigm* of Fishbein and Ajzen (1975), Ajzen and Fishbein's (1980) *Theory of Reasoned Action* (TRA), Ajzen 's *Theory of Planned Behaviour* TPB (1985, 1991), and recently the *Reasoned Action Framework* (Fishbein & Ajzen, 2010). The psychology attitude paradigm specifies how to measure the behaviour-relevant components of attitudes, distinguishes between beliefs and attitudes and specifies how external stimuli such as the objective features of an attitude object, are causally linked to beliefs, attitudes and behaviour (Fishbein & Ajzen, 1975).

This section describes the following motivational theories: the trait perspective, the cognitive perspective, the theory of reasoned action, and the Theory of Trying.

The Theory of Reasoned Action has its roots in personality theory and in particular in three perspectives: trait perspective, behaviourist perspective and cognitive perspective. Trait perspective is represented by Gordon W. Allport's Trait Theory, the Factor Analytic Trait Theory by Raymond B. Cattell and others, Eysenck's Three-factor theory and the Five Factor Theory or Big Five Theory (Costa & McCrae, 1992). The cognitive perspective is represented by George A. Kelly and his Personal Construct Psychology (PCP) and Albert Bandura's Social-cognitive Theory. The Trait Theory, Three Factor Theory, and Big Five Factor Theory are explained in the following section. The Trait Theory review is then followed by Bandura's Cognitive

Theory and the Theory of Reasoned Action. The Theory of Reasoned Action section includes: the Theory of Reasoned Action by Fishbein and Ajzen (1975), the Theory of Planned Behaviour (TPB), and the Decomposed Theory of Planned Behaviour (DTPB).

### **2.1.1. THE TRAIT PERSPECTIVE**

This section explains Allport's Trait Theory, Cattell's Theory, Eysenck's Three Super Traits Theory and Big Five Traits Theory. Trait theories developed by Allport "sought to describe and explain personality by using the familiar constructs of traits: friendly, ambitious, enthusiastic, shy, punctual, talkative dominating, generous and so forth ..." (Allport G. , 1954). Allport started from the premise: "If you want to know something about a person, why not first ask him?" (Allport G. , 1954). He estimated that 4000-5000 traits exist with 18000 names for them. He defines trait as "... a neuropsychic structure having the capacity to render many stimuli functionally equivalent, and to initiate and guide equivalent (meaningfully consistent) forms of adaptive and expressive behaviour" (Allport, 1961, p. 333). Allport argues that every personality is unique and that we are motivated by our plans for the future and our prior causes. Allport and Murray were the first personality theorists to actively try to find empirical support for the theory by conducting experiments and using statistical analysis. Allport's objective was to devise a theory that focused on conscious and concrete aspects of personality. Allport's theories diverged from other theories in beliefs, such as the first two years of life were considered by him relatively unimportant. He also argues that adults' motives differ radically from childhood motives and that all forms of psychopathology differ in kind rather than in degree (Ewen, 1998). Allport's major contribution is the familiar constructs of traits (ambitious, shy, talkative, etc.). Allport defines traits as description of personality in terms of consistent patterns of behaviour. Ewen (1998, p. 123) defines the trait as "neuropsychic structures that initiate and guide the many consistent aspects of behaviour". Allport also identifies common traits as ones by which people can be compared.

The criticism of Allport's theory lies in his underestimation of the importance of early childhood for personality development. It has been argued by others that trait theory relies very heavily on circular reasoning. The circular reasoning is explained by the fact that the existence of a trait is inferred from certain behaviour and then used to explain that behaviour. It is also argued that trait does not explain anything on its own, it is only describing the behaviour by giving it a name without explaining why we do the things we do. The second limitation is the emphasis on concrete and conscious aspects of personality and at the same time ignoring human aspect of the personality.

Carl Jung (1995) has reduced the number of traits to the two prominent ones of introversion-extroversion which are very relevant today. He argues that introvert people will more likely be alone and more interested in their inner self. The extroverted people will be more oriented towards other people and external events. Jung also defines four ways in which we capture stimuli: thinking, feeling, sensation and intuition.

The excessive number of traits identified by Allport has been analysed by Raymond Cattell (1982) using factor analysis. Cattell argued that psychology must become far more objective and mathematical if it is to be true science. He worked on mathematical equations that can be used to predict human behaviour from trait scores and identified which traits are more influenced by hereditary factors. Cattell has developed personality inventory measurement to identify source traits (Sixteen Personality Factor Questionnaire or 16 P.F.Q). The main criticism of this work is that he has used a large amount of unusual new words in his work, and his work is mostly ignored. The reason why his work is ignored is that psychologists prefer to make diagnosis on theoretical grounds rather than practical ones. Ewen argues that factor analysis is useful for dealing with large correlation matrices but its use for testing hypotheses is debatable.

Following up in the trait theory research is Eysenck, who has developed a three factor super trait theory.

#### *2.1.1.1. EYSENCK'S THREE FACTOR THEORY*

Eysenck also applied factor analysis in his research and identified three super traits: introversion-extroversion, neuroticism and psychoticism. His objectives were to identify the most important traits and to make the traits theory more explanatory by connecting the traits to psychological and social causes, following from Cattell's theory. Cattell had been criticized because his theory does not explain why we do what we do. Eysenck argues that the major role in determining a person's traits is played by heredity (Eysenck, 1966). He argues that 75% of the variation in introversion-extroversion is explained by heredity as opposed to other researchers who believe that this percentage is somewhere between 20%-50%. (Ewen, 1998). He specified that high score neuroticism people tend to be emotionally unstable while those with low scores are more stable. People with high scores on psychoticism are egocentric (it is all about me), aggressive, and have a lack of concern for the feelings of others. However, the use of factor analysis does not guarantee the perfect result according to Ewen (2010) and it is very difficult to decide which of the traits to include in the correlation matrix to be analysed. Many researchers believe that many more factors need to be included.

In summary, one of the most important objectives for Eysenck was to identify which of many of Cattell's traits are the most important ones by using factor analysis. His research resulted in the three super traits which he identified. They are introversion, neuroticism and psychoticism. This theory laid the foundation for the development of the big five factor theory.

#### *2.1.1.2. "BIG FIVE" (FIVE-FACTOR) THEORY*

Many researchers felt that Eysenck's three super traits are quite limited and Cattell's 4000 traits are too complex and very difficult to manage, and the big five theory emerged from subsequent research. The five traits theory had been developed from factor analytic studies. The objective of this theory was to determine the most important traits (similar to Eysenck's objective). It also made an effort to demonstrate that these most important traits represented the core of personality. As a result of the last 50 years of research, five core personality traits

have emerged. It started with the research of Fiske (1949) and was expanded later by many other researchers (Goldberg, 1981; McCrae & Costa, 1987; Norman, 1963). Norman had replicated Tupes and Christal's (1961) study in which they used Cattell's trait measure and had found that five factors were continually recurring. Norman named these factors Surgency, Agreeableness, Conscientiousness, Emotional Stability and Culture.

The Big Five Theory (also known as the Five Factor Model FFM) includes extroversion and neuroticism from Eysenck and Jung. In addition to these two it has added agreeableness, conscientiousness and openness. The Big Five Theory defines extroversion as "aloof and retiring versus sociable and talkative", neuroticism as "calm and secure versus nervous and insecure", agreeableness as "suspicious and uncooperative versus trusting and helpful", conscientiousness as "lazy and unreliable versus hardworking and reliable" and openness to experience as "conventional and down-to-earth versus nonconformist and creative" (Ewen, 2010, p. 281). The Big Five Theory is the dominant theory at the present and its most significant contribution is in the establishment of a common taxonomy in a field that previously did not have an organization and an order. The validation of the theory had been performed in the area of job performance. Barrick and Mount (1991; Mount & Barrick, 1998) had found that extroversion was a valid predictor for social interactions and extraversion with openness was a good predictor of training proficiency criteria. The criticism is that the theory provides only the surface information of a personality and that in order to fully understand personalities it is necessary to consider other theories as well. It has been argued that the big five theory is not based on any personality theory but on the language and the way people verbally express themselves. It has been argued also that factor analysis is challenged for not having a way of choosing among many solutions with different numbers of factors. Another criticism is that the methodology relies on self-reporting and it is difficult to deal completely with self-reported bias. The quality of the analysis relies on a person deciding which factors are going to be analysed. The popularity of the big five is attributed to the fact that it is less complicated than Cattell's and it includes the three super traits from Eysenck's theory. These five

traits remain consistent during adult life despite some life changing experiences (job, marital status, geographical position, etc.) that individuals may experience.

In summary the Big Five Theory includes two Eysenck's super traits, neuroticism and extroversion, in addition to agreeableness, conscientiousness and openness as core personality traits. The most important impact of this theory is a definition of taxonomy in the field which previously did not have this type of order.

### **2.1.2. THE SOCIAL-COGNITIVE PERSPECTIVE**

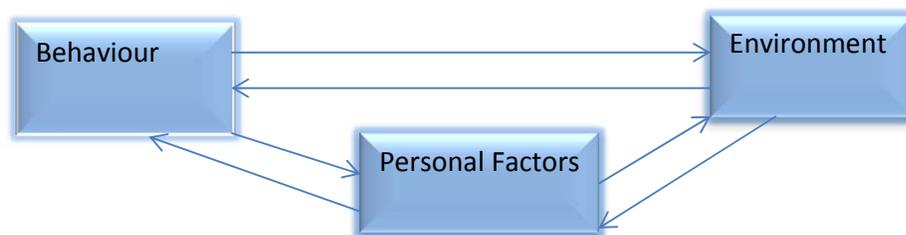
The theories that put strong importance on the thinking process and advocate that behaviour is determined by our own construct, prediction, and evaluation of events, rather than by our reality or instincts, is called cognitive perspective. Albert Bandura is one of the cognitive researchers who put special significance on the inner causes of behaviour, which includes our thinking, our self-perception, and beliefs. In his theory that explores beliefs about the behaviour, he specifically investigates and defines self-efficacy construct as an important part of this theory. Bandura's Social-cognitive Model is explained below.

This section briefly describes Kelly's psychology of personal constructs (PPC) and explains Bandura's cognitive theory, his reciprocal determinism and particularly his self-efficacy term.

Kelly argued that we all create our own reality and tested this suggestion in a way that a scientist would. He debated that we interpret our reality in our own way in an attempt to achieve the feeling of order and control over our environment. He also highlighted the importance of the different ways our cognition works, our empathy to other people's constructs (constructive alternativism) and the way this affects our interpersonal relationships. He argued, that regardless of the accuracy with which we construct or interpret the external world, meaning comes from our creative interpretation of that reality (Kelly, 1955). He recognised the uniqueness of personality and provided guidance for its study. His specific contribution is in his attitude toward his own theory as a limited and expendable tool which is quite different from other researchers. He emphasised that there are many ways of

interpreting and predicting the world in our own constructs and these constructs are the ones that determine our behaviour.

Bandura in his Social-cognitive Theory (also called social learning theory) emphasised the mutual relationship between behaviour, internal causes, and environmental factors. He wrote “that behaviour, environmental influences, and internal personal factors (including beliefs, thoughts, preferences, expectations, and self-perceptions) all cause and can be caused by each other (reciprocal determinism)” (Ewen, 2010, p. 342). Bandura’s reciprocal determinism is shown in Figure 2-1.



*Figure 2-1.* Bandura's reciprocal determinism. (Ewen, 1998, p. 238)

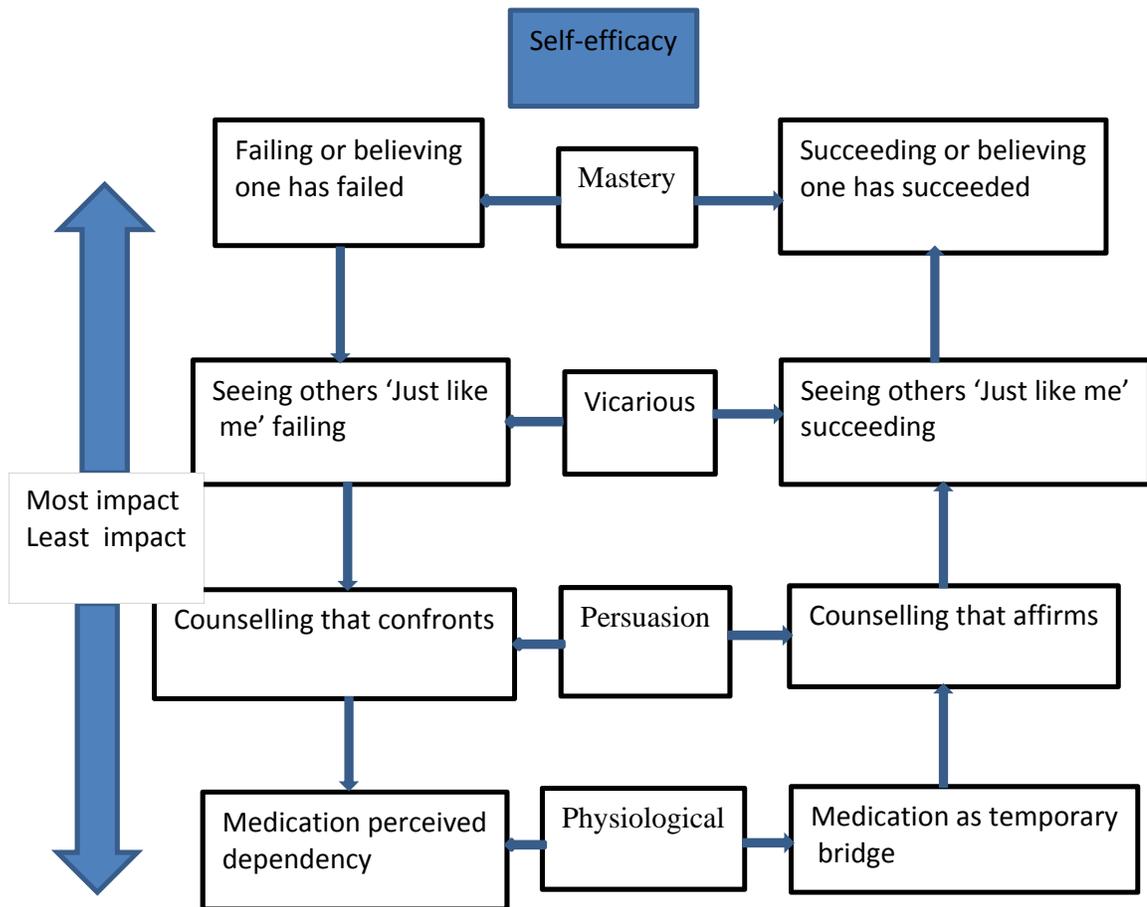
Bandura’s objective can be identified as extending behaviourism theory by emphasizing the importance of inner causes of behaviour (expectations, self-perception, beliefs...). He argued that there is “growing evidence that cognition has a causal influence on behaviour... [and that theory which] denies that thoughts can regulate action does not lend itself readily to the explanation of complex human behaviour” (Bandura, 1977, p. 10). He identified the need to correct and extend external influences of the environment and that we also have reciprocal influence on the environment itself. Bandura specified that we set standards for ourselves and reinforce ourselves for doing well. He argued that this self-reinforced behaviour is likely to be maintained much better than an externally reinforced one. He argued that the majority of human learning happens through observations, and does not have to involve reinforcement. The reinforcement is defined as an increase in the frequency of certain behaviour because of expectations that will gain rewards or

avoid punishment. He also argued that the extent to which we believe that we can perform the required behaviour by an action (perceived self-efficacy) has a significant effect on our behaviour. Self-esteem is the term closely related to self – efficacy and self-concept and deals with how we evaluate ourselves. It also represents the accumulation of the knowledge about the self, our beliefs regarding personality traits, abilities, values, goals and roles. Bandura argues that: “Simply saying that one is capable is not necessarily self-convincing. Self-efficacy beliefs are the product of a complex process of self-persuasion that relies on cognitive processing of diverse sources of efficacy information” (Bandura, 1995, p. 11). The literature reveals that there are many concepts defined by different theorists about self-efficacy. Maslow defined his concept of self-actualisation “What man can be, he must be” (Maslow, 1968, p. 33) as fulfilling one’s own potential. Rogers (1951) defines it as the tendency to satisfy the need of one’s self-concept. He also defined self-concept as the learned conscious sense of being, which is unique for every person. Rogers (1961) and Sullivan (1953) defined self-esteem as how favourably or unfavourably we evaluate our own self-concept.

Bandura defined perceived self-efficacy as the extent to which a person believes that he or she can perform the behaviour required by a particular situation. Self-reinforcement has been defined by Bandura as establishing one’s own standards of behaviour and praising or criticizing oneself accordingly. He noted “In the social learning view, people are neither driven by inner forces nor buffeted by environmental stimuli. Rather, psychological functioning is explained in terms of a continuous reciprocal interaction of personal and environmental determinants...” (1977, p. 11).

Bandura argued that perceived self-efficacy is influenced by observational learning. He defined observational learning as learning by observing other people’s behaviour and the consequences of this behaviour for them. Observational learning involves formulating the rules, concepts, and conclusions based on observations. These inferences may lead to behaviour which is similar but not identical to the original behaviour. The reinforcement is playing a role in the way that reward will increase likelihood of the behaviour (vicarious reinforcement) and punishment will

decrease it (vicarious punishment). The simplified concept of socio-cognitive model of self-efficacy is shown in **Figure 2-2**



*Figure 2-2.* Simplified model of Bandura's self-efficacy constructs.

The model attempts to explain self-efficacy construct in four levels of building or developing the self-efficacy: psychological, persuasion, vicarious and mastery. The physiological level deals with people who have a low self-efficacy and are in need of medical support. It explains that perception of the effectiveness of the help is very important in building self-efficacy. A medical support can be seen as positive if it is perceived as a temporary measure on the journey of building self-efficacy. It would therefore result in the start of a process of building a person's self-efficacy. Medical support also has a negative side if it is perceived by the person as depending on this support continuously. This kind of dependency would make a person believe that

he or she could not do it without this support and therefore damage whatever self-efficacy they may have.

Persuasion is defined as the next step on the journey and represents the interaction of a person with supporting people. If that support is affirming it is likely that a person would continue on the journey of building their self-efficacy. It would help by making people feel better about themselves, however confronting counselling could provoke the opposite by making a person feel the need to defend their present position and therefore, negatively reinforce this low self-efficacy feeling, and generally making things worse.

The vicarious level deals with learning by observation and believing that the same can be achieved. Positive reinforcement comes from a person observing people in a similar condition who are succeeding. It will then reinforce the feeling that the same is achievable by them. However, seeing people in the same situation failing would reinforce the feeling that an objective is not achievable and result in low self-efficacy with the person being convinced that it is not possible to succeed.

The last level is a mastery level in which one believes that one can succeed, have skills to do it, and the perseverance to sustain the effort. The most important part of this level is perseverance in achieving a goal. The belief that it is possible to achieve the goal, that one has the skills and is able to persevere until the goal is achieved is a mastery of self-efficacy for the person. The opposite however, that one believes that the goal is not achievable, that one has not the required skills and perseverance to do it would result in the person withdrawing from the activity completely and failing. This result would have a serious impact on self-efficacy.

Self-efficacy is used in this study to investigate the degree of self-ability to use Salsa software for the management of students' learning. It has been argued that self-efficacy in the computing field is specific to the field and it is called computer self-efficacy. Some researchers investigated the influence of computer self-efficacy on the usage of a software system (Compeau & Higgins, 1995). Computer self-efficacy was also used by Saade and Kira (2009) who investigated the relationship between computer anxiety, computer self-efficacy and perceived ease of use. They argued

that computer self-efficacy plays an important role in mediating the impact of computer anxiety on perceived ease of use.

Self-efficacy has also been compared to perceived behavioural control by Fishbein and Ajzen (1980) in their theory of planned behaviour. Fishbein has argued that control beliefs are people's beliefs about personal and environmental factors. These beliefs would then result in a feeling of a high or low self-efficacy belief or perceived behavioural control. Therefore, Fishbein is identifying both self-efficacy and behavioural control as equal whereas Bandura strongly disagrees. Some other studies supported Bandura's view (Kraft, Rise, Sutton, & Roysamb, 2005). However, none of the studies support the idea that PCB [perceived control of behaviour] should be perceived as reflecting self-efficacy (consisting of CON [control] and PD [perceived difficulty]) and controllability (consisting of PC and LOC [locus of control]), as suggested by Ajzen (2005). The difference is that Fishbein does not identify perseverance as an important part of self-efficacy and is more focused on environmental factors.

In summary the importance of Kelly's psychology of personal construct is in the emphasis that each one of us creates our own construct of the world and our interpretation of it. These constructs are unique to each one of us and determine our behaviour. Bandura's social cognitive theory's importance lies in its impact on learning. His strategies of modelling appropriate behaviour and building self-efficacy are part of his theory. He argues that a person's attitude, abilities and cognitive skills entail a concept of self- system. This system plays a major role in how we respond to any situation. Self-efficacy and the methodology of how it could be developed are explained. Fishbein's understanding of behavioural control and his focus on environmental factors were added. The difference between Bandura's and Fishbein's understanding of self-efficacy are noted. Fishbein does not identify perseverance as a part of self-efficacy and believes that self-efficacy is equivalent to his behavioural control. His concept of theory of reasoned action is explained below.

### 2.1.3. THE THEORY OF REASONED ACTION

The Theory of Reasoned Action is one of the psychological models that explores intentional behaviour. It assumes that users are rational and will consider the possible implications of his/her actions prior to making a decision on how to behave (Ajzen & Fishbein, 1980). The theory suggests that most behaviours are under the user's own control and as such are predictable. It also suggests that the relationship between intention and behaviour "depends on two factors: (a) the measure of intention must correspond to the behavioural criterion in action, target, context, and time; and (b) intention does not change before the behaviour is observed" (Yousafzai, Foxall, & Pallister, 2010, p. 1174). It identifies that behavioural intention has two contributing factors: a personal factor (attitude toward behaviour) and perceptions of social pressures (subjective norms). Figure 2-3 shows the theory of reasoned action.

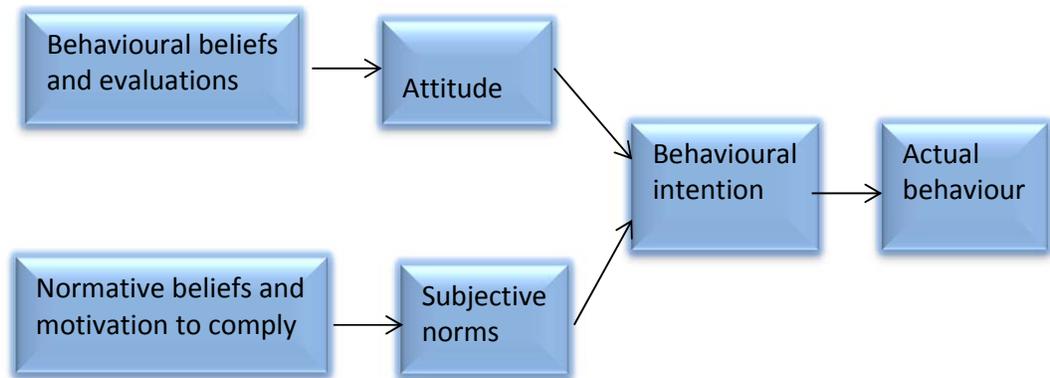


Figure 2-3. Theory of Reasoned Action. (Fishbein & Ajzen, 1975, p. 288)

Attitude is defined by Fishbein and Ajzen (1975, p. 6) as "a learned predisposition to respond in a consistently favourable or unfavourable manner with respect to a given object". Subjective norms are defined as a function of a set of normative beliefs (1975). Normative beliefs are defined as behaviours that would be approved or disapproved by important individuals or groups in the society. In order to use the

theory of reasoned action, a researcher must first identify significant beliefs of investigating behaviour for the participants. Secondly, the theory is limited in predicting the behaviour for only the situations where intention and behaviour are highly correlated. Thirdly, it assumes that behaviour must be under the individual participant's control. Therefore, the theory of reasoned action is not suited for prediction in situations where individual participants are not fully in control.

The Theory of Planned Behaviour (TPB) is an extension of the Theory of Reasoned Action and suggests that one more element (perceived behavioural control- PBC) influences behavioural intention. It also diverges from the previous theory by including the situations in which participants do not have complete control. The model of the Theory of Planned Behaviour is shown in Figure 2-4.

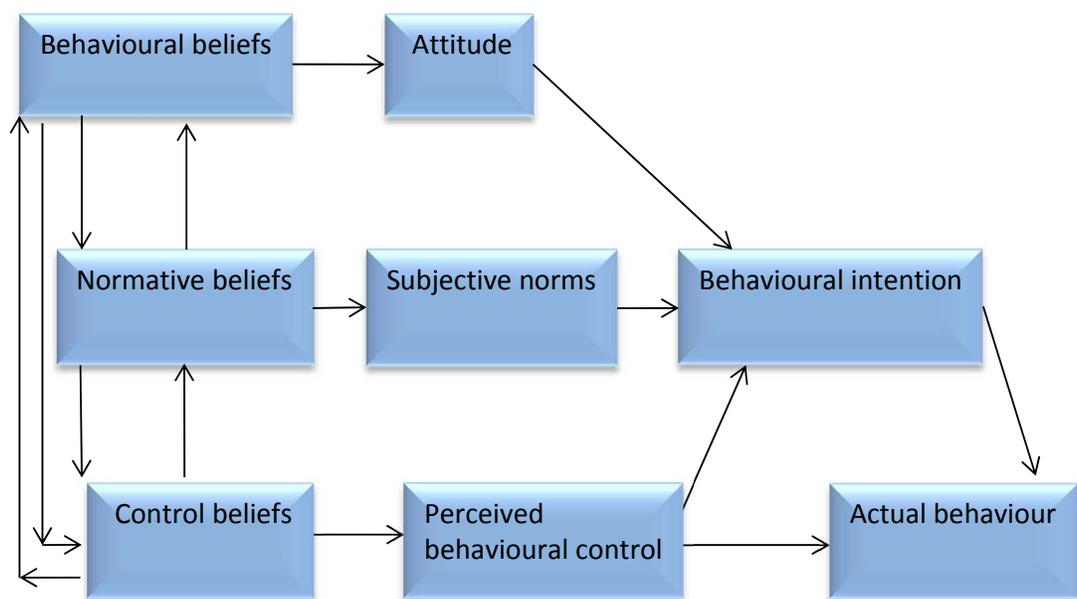


Figure 2-4: Theory of Planned Behaviour. (Ajzen, 1991, p. 179)

The Theory of Planned Behaviour indicates that there are three considerations with regard to human action: behavioural beliefs, normative beliefs and control beliefs. Control beliefs are identified as having or not having resources and opportunities and identifying obstacles toward performing the targeted behaviour. Both the

Theory of Reasoned Action and the Theory of Planned Behaviour assume correlation between intention and behaviour and a “*causal link between perceived behavioural control and intention*” which assumes that people’s engagement depends on their decision as to whether or not they can achieve the objective (Yousafzai, Foxall, & Pallister, 2010, p. 1176). This, as presented, has only one more factor in addition to the two already existing in the Theory of Reasoned Action. Many researchers (including Ajzen himself) argue that there is evidence that many more factors should be included.

#### 2.1.3.1. THE DECOMPOSED THEORY OF PLANNED BEHAVIOUR

The Decomposed Theory of Planned Behaviour has all three belief structures decomposed into a multidimensional model structure. For example, attitude is decomposed into: relative advantage (which is analogous to Perceived Usefulness from TAM), complexity and compatibility. Taylor and Todd (1995a) used the definition of relative advantage by Rogers (1983, p. 152) as “the degree to which an innovation provides benefits which supersedes those of its precursors and may incorporate factors such as economic benefits, image enhancement, convenience and satisfaction”. They also defined *complexity* as “the degree to which an innovation is perceived to be difficult to understand, learn, or operate.” and *compatibility* as “the degree to which the innovation fits with the potential adopter’s existing values, previous experience and current needs.”

Taylor and Todd further decomposed normative beliefs into a peer Influence and superior Influence, arguing that normative beliefs for the different groups may differ. This differentiation may result in no difference in normative structure because of the fact that different effects of the groups may cancel each other’s effect.

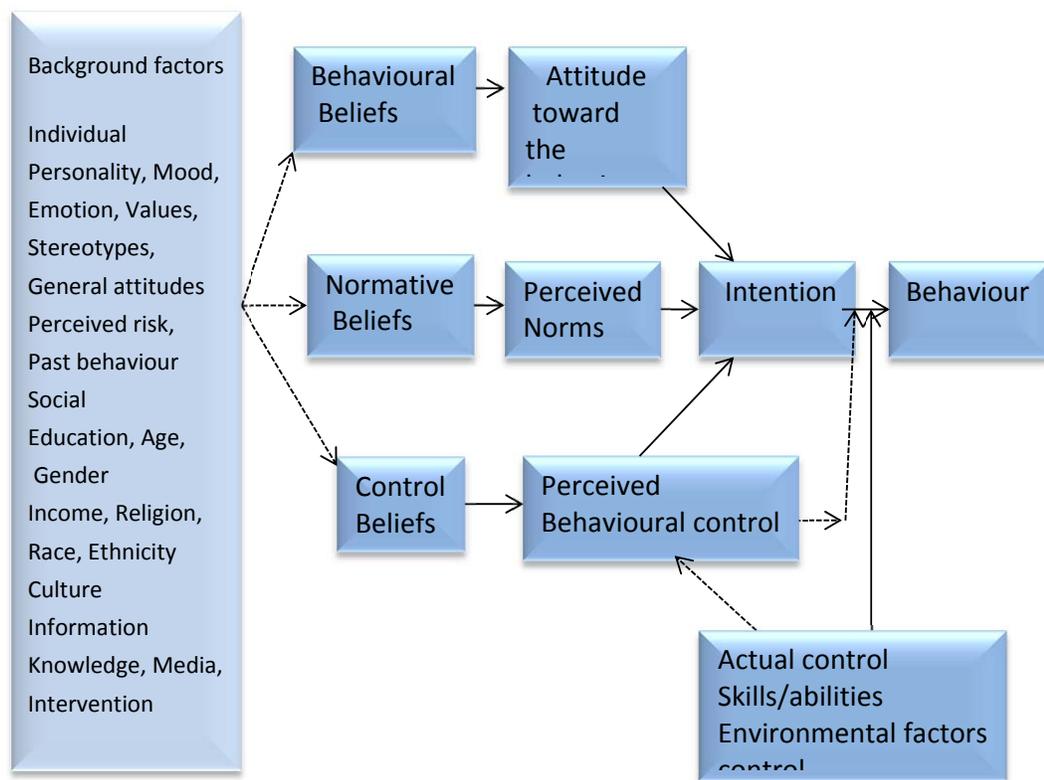
Decomposition of control beliefs structure was defined as internal “*self-efficacy*” (perceived ability) and external resource constraints. Self-efficacy has been researched by Bandura within his Socio-cognitive Model (explained previously) over the last 30 years. Perceived self-efficacy has been defined as the extent to which a person believes that he or she can perform the behaviour required by a particular

situation. Taylor and Todd suggested that the perceived ability of the person believing that she/he can perform the activity, has the skills that are required, and the determination to do it, would result in an increased behavioural intention to use and usage of information technology. They also stated that the lack of external resources would weaken behavioural intention, therefore impacting on the usage of information technology. However, the opposite is not true. The availability of resources, per se, would not guaranty high use and usage of information technology.

The Decomposed Theory of Planned Behaviour better clarifies relationships between beliefs. By focusing on one special group the process becomes more relevant to managers wishing to identify specific beliefs for the particular group. The set of beliefs once identified for the special group could then be applied to different situations in a system design and a strategy for implementation. This is very similar to the Technology Acceptance Model. The difference is that decomposed theory of planned behaviour is more complex to implement then technology acceptance model because of the larger number of factors that are taken into account in the Decomposed Technology Acceptance Model.

In an attempt to include a wider range of possible influencing factors, Fishbein and Ajzen developed in 2010 an extended model of the Theory of Reasoned Action. They argued that the starting point of the analysis is to identify the behaviour to be investigated and then to identify its determinants. They then argue that people's behaviour is based on their beliefs and previous knowledge about the behaviour in question. They define the beliefs as based on people's experiences, education, information they are exposed to, etc. These beliefs then guide one's decision to perform or not to perform the required behaviour. They define these three types of behaviour as: behavioural beliefs, normative beliefs and control beliefs. A special addition to this model represents the extension of control beliefs behaviour's determinants. They argue that personal and environmental factors form these beliefs and consequently affect our effort to perform this behaviour. These control beliefs then result in a sense of our self-efficacy (Bandura, 1995) or perceived behavioural control. Low self-efficacy will result in not attempting the behaviour

and high self-efficacy will support the intent to perform the behaviour. After the behavioural beliefs, perceived norms and perceived behavioural control are formed they lead into behavioural intention readiness to perform the behaviour (Fishbein & Ajzen, 2010). They argue that the higher behavioural beliefs, higher norms and higher control behavioural beliefs will result in a higher intention to perform the behaviour. The concept of this new framework for the Theory of Reasoned Action is shown in *Figure 2-5*.



*Figure 2-5.* The theoretical framework for the Theory of Reasoned Action.  
(Fishbein & Ajzen, 2010, p. 22)

Fishbein and Ajzen do not have Rogers’s self-actualisation in their model. They also disagree with Bandura’s opinion that perseverance in achieving the goal is important. They argue that Bandura’s self-efficacy is equivalent to perceived behavioural control in this model. This is not entirely accurate because Fishbein and Ajzen do not recognise within his model personal norms such as self-identity and

personal goals. The personal goal is included in the Bagozzi's Theory of Trying explained in section 2.1.4 of this chapter.

In the 1980 's, the National Institute of Mental Health (NIMH) asked five theorists (Albert Bandura, Martin Fishbein, Frederick Kanfer, Marshall Becker, Harry Triandis) to agree on a set of variables that can be used in any behavioural analysis. They have agreed that for a person to perform a required behaviour the following variables are necessary and sufficient: the person has formed a strong and positive intention or commitment to perform the behaviour; no environmental constraints exist to make it impossible to perform the behaviour; and the person has the necessary skills to perform the behaviour. They also defined five additional variables which are seen as determinants of intention. The person has positive attitudes and beliefs and the advantages that the performing of the behaviour are greater than the disadvantages; the person perceives more social pressure to perform the behaviour than not; that to perform the behaviour is more consistent with his/her self-image and therefore does not violate personal standards; that the person's emotional reaction is positive rather than negative, and that the person perceives that he/she has the skills to perform the behaviour (Fishbein & Ajzen, 2010).

In summary, this section has explained the basics of the following models: Theory of Reasoned Action, Theory of Planned Behaviour, Decomposed Theory of Planned Behaviour and the new framework for the Theory of Reasoned Action. It started with Theory of Reasoned Action which is comprised of the behavioural beliefs which form an attitude, and an attitude towards behavioural intention. Normative beliefs would form subjective norms. Both attitude and subjective norms would then form behavioural intentions which would then lead to a formation of an actual behaviour. This model has been expanded to include additional control beliefs and to form the Theory of Planned Behaviour. Control beliefs would form a perceived behavioural control. Perceived behavioural control would then together with attitude and subjective form a behavioural intention to actual behaviour. The third model explained in this section was the Decomposed Theory of Planned Behaviour. This theory has all three beliefs (behavioural beliefs, normative beliefs and control

beliefs) decomposed into a multidimensional structure. The last model presented was a new framework for the Theory of Reasoned Action. This model differs from the previous models in structure of perceived behavioural control. The behavioural control has been decomposed into actual control over skills/abilities and environmental control. It also allowed for inclusion of additional constructs from social information and individual background. Fishbein and Ajzen (1975) argued that only personal and environmental factors form control beliefs. They argued that these beliefs then result in our self-efficacy or perceived behavioural control. Bandura's (1977) view of self-efficacy includes the goal orientation and perseverance and determination to achieve the goal which Fishbein does not recognize.

In addition to theories of reasoned action which attempted to define the intention and the behaviour of technology use, Bagozzi (2007) introduced the Theory of Trying. The Theory of Trying attempts to explain the role of learning to use technology rather than technology use itself. This theory is explained in the following section.

#### **2.1.4. THEORY OF TRYING**

The Theory of Trying has been developed by Bagozzi and Warshaw (1990). They focused on explaining the role of learning to use computers rather than explaining the act of using them. They argued that inadequate learning can restrain and impact the adoption of technology. In their analysis they stated that the Theory of Reasoned Action and the Technology Acceptance Model did not address the consequences of trying and failing in the decision process and therefore proposed a new Theory of Trying. Bagozzi and others have proposed theories of trying which differed from the Theory of Reasoned Action in the assumption that attitudes toward goals are more complex than attitudes toward action. They argued that attitudes toward goals are multidimensional in contrast to attitudes toward the action which are unidimensional. Bagozzi (2007) argued that there are three dimensions of attitude toward goals: attitudes toward the consequences of

succeeding, attitudes towards consequences of failing and attitudes toward the process of striving to achieve the goal. His model differs from that of Ajzen (1985) in the third assumption regarding the process of achieving the goal which Ajzen assumed to be already addressed within attitude toward successful behavioural attempts and therefore rejects it.

Bagozzi and Warshaw (1990) explained that the process starts with intention to try to achieve the goal, and then this intention will initiate trying to achieve the goal. He defined the trying as the effort one puts in to achieving the goal. The process would involve starting and monitoring acts on the way to achieving the goal. He defined the sequence in his theory as goal directed attitude → intentions to try → trying usage. He compared his model to the theory of reasoned action sequence, attitudes toward using → intentions to use → usage. He defined the sequence for technology acceptance model as, perceived usefulness and ease of use → intentions to use → usage (Bagozzi, Davis, & Warshaw, 1992, p. 664). He argued that many users fail to use technology because they never learned how to use it. He identified that use of the technology is affected by both the intention to use and the degree to which user tries to learn how to use the technology. He argued that implantation of risk reduction strategies may influence intentions to try to learn. Some of the suggested strategies are using “undo” and disabling advanced commands. He suggested using simulation, games and interactive learning to increase the likelihood of authentic learning and consequently, correct and increased usage of technology.

In summary, the Theory of Trying further explores the role of learning how to use computers rather than computer use itself. Bagozzi argued that goal intention and monitoring is the essence of learning to use the technology. He argued that failing in trying (learning) would impact on the usage as well as the perceived usefulness and perceived ease of use. The impact of learning is so strong that it may stop people using the technology if the learning process was unsuccessful. He suggested new and innovative strategies to attract the learning process such as games, simulations, etc.

Bandura (1997), in his socio-cognitive theory had developed the self-efficacy construct defined as, our beliefs that we can perform the required behaviour by action (perceived self-efficacy). He defined the levels of mastering the self-efficacy. His reciprocal determinism had been explained as our need to correct and extends the external influences of the environment and our reciprocal influence on the environment itself. The role of observational learning was shown as central to the process of learning. He argued that reinforcement does not have to be part of the learning. He also identified that self-reinforcement is stronger and is likely to be maintained much more effectively than external reinforcement. The difference between Bandura's self-efficacy and Fishbein's behavioural control has been identified. Fishbein did not identify a goal and perseverance in his perceived behavioural control construct of his theory of reasoned action. Bandura and author of this thesis strongly disagree with Fishbein.

The Theory of Reasoned Action model was the basis for Davies to develop a model to investigate people's attitude toward software acceptance. Davies developed the Technology Acceptance Model (commonly called TAM) for this particular purpose and has researched the users' attitudes for software adoption over the last three decades. His model is presented in the following section.

## **2.2. TECHNOLOGY ACCEPTANCE MODEL**

The first part of the section covers the Technology Acceptance Model concept and the first variation of the original TAM, named TAM2. The second part covers the Unified Theory of Acceptance and Use of Technology Model (UTAUT) introduced by Venkatesh and Davis (2000), and UTAUT developed by Venkatesh and Bala (Venkatesh & Bala, TAM 3: Advancing the technology acceptance model with focus on interventions Manuscript in-preparation). The third part explains the new version of the UTAUT Technology Acceptance Model, TAM 3. To end the section, a sample of literature review is outlined.

The Technology Acceptance Model (TAM), developed by Davis (1989), is based on the theory of reasoned action and is considered to be a special case of that theory. The Technology Acceptance Model is used to explain how readily the user accepts the technology. One of the driving forces in the expansion of the research with the Technology Acceptance Model was the practical implications of its results. The result of the research informs software designers and therefore directly influences the design of the software. It also impacts indirectly on usage of that software and therefore usage of the technology in a particular environment. Investigating an attitude towards software use, with the Technology Acceptance Model, helps the designers of the software to better understand the user's attitude when interacting with the software. This better understanding will result in better understanding of how to improve the software in order to align it with the users' preferences. Ultimately, all this will result in a better understanding of technology usage and higher usage of technology in a particular organization. So in conclusion it is assumed that a better understanding of usage will inform and improve software design and therefore influence acceptance or rejection of the technology. It is expected that higher usage will also increase productivity and therefore justify the information technology investment by the organization.

### **2.2.1. TECHNOLOGY ACCEPTANCE MODEL TAM AND TAM2**

Davis (1986) introduced the Technology Acceptance Model as a model which explains user acceptance behaviour in the process of adopting new software. The proposed technology acceptance model was very simple to use. This model used only two constructs to explain user acceptance or rejection of the technology. The constructs used in the model (according to Davies) are defined as Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Davis argues that intention to perform the behaviour (to accept or reject the technology) is defined with these two factors only. These two factors influenced the formation of behavioural intention to use technology. The behavioural intention to use technology would form the actual behaviour to use the technology. If the Perceived Usefulness was

seen as high and Ease of Use as high, the person was likely to have a positive intention to use the technology. This positive intention to use would result in actual behaviour of using the technology. If on the other hand both of these constructs are seen as negative then it would create negative intention and consequently the person would reject the use of the technology. In the case that Perceived Usefulness was seen as positive and Perceived Ease of Use as negative, people were still likely to use the technology believing that it would help them to perform their task better. If on the other hand the Perceived Usefulness was negative and Ease of Use was high people were not likely to use the technology since no Ease of Use would motivate them to accept the technology if there was no Perceived Usefulness in it. Davis reported that Perceived Usefulness was significantly more strongly linked to usage of the system than perceived Ease of Use. The model provided insights into a better understanding of how system characteristics could influence user attitudes towards software and as a result of its usage.

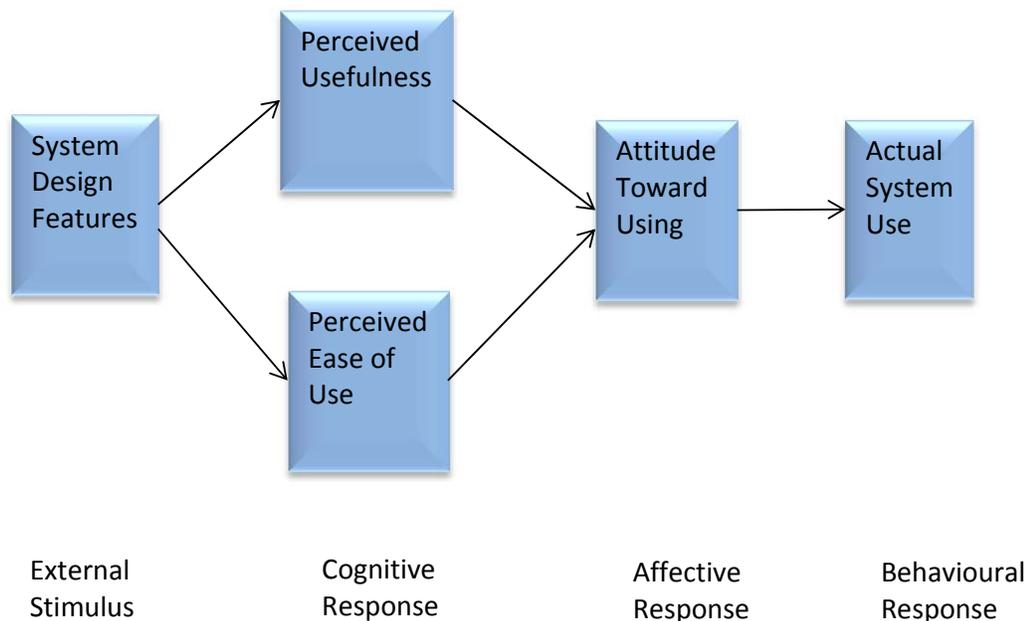
Perceived Usefulness was identified by Davis as “the degree to which an individual believes that using a particular system would enhance his or her job performance.” (1993, p. 477). Perceived Ease of Use was defined as “the degree to which an individual believes that using a particular system would be free of physical and mental effort.” (1993, p. 477). These two specific constructs in user acceptance criteria were identified as important by many researchers (Davis, 1989; Goodwin, 1987; Gould, Boies, & Lewis, 1991; Hill, Smith, & Mann, 1987). According to Davis the two constructs are two statistically distinct entities.

The model addressed two points in users’ decisions. The first one was why the user accepts or rejects the information technology. The second one was how user acceptance was influenced by systems characteristics. The better understanding of these users’ decisions would help to improve acceptance through the impact that this understanding would have on the design of the system. Davis argued that the Technology Acceptance Model might have a practical impact for an early user acceptance of technology. Identifying early acceptance and attitude toward the system in design phases would inform making the key decisions early, would incur less cost for redesign (early phases of development) and made improvement easier.

The early testing of the systems by the users is encouraged in today's design practice; however, it is not clear how much this reflects the level of user acceptance that would happen after system implementation.

The popularity of Davis' Technology Acceptance Model was attributed to its simplicity (as already suggested and the fact that it is generic and can be used across a range of technologies and a broad range of users to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behaviour across a broad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis, Bagozzi, & Warshaw, 1989, p. 985).

The conceptual structure of Davis's technology acceptance model is shown in **Figure 2-6**.



*Figure 2-6. The Technology Acceptance Model TAM (1993, p. 481).*

This first Technology Acceptance Model as shown in Figure 2-6 took into account only external factors (extrinsic), such as concern over performance gains and associated rewards. The model however, did not take into account the intrinsic

motives of users which also play an important role in the usage of computer systems. People today use the systems for enjoyment of using it per se, without being specifically rewarded for it. Examples of use for enjoyment are playing games or participating in a chat rooms, etc. The Davis model was based on the concept that the actual use of the system was determined mainly by the potential attitude towards using the system. Davis defined user motivation with the following three constructs: Perceived Usefulness, Perceived Ease of Use and Attitude Toward Using. He theorized that Attitude Toward Using was determined by Perceived Ease of Use and Perceived Usefulness. He argued that Perceived Ease of Use had a causal effect on Perceived Usefulness. He considered the system characteristics to be external variables (as within Fishbein's model) and therefore not having a direct effect on attitude.

The theoretical background of the Technology Acceptance Model was based on principles of Fishbein and Ajzen's (1975) attitude paradigm from psychology. The Fishbein model was well founded on the theory of motivational linkages between external stimuli (system characteristic was one example) and user final behaviour. Fishbein and Ajzen defined an *attitude toward behaviour*  $A_B$  by the *expectancy-value model of beliefs* ( $b_i$ ) weighted by *evaluation of the consequences* ( $e_i$ ):

$$A_B = \sum_{i=1}^n b_i e_i$$

Attitude toward the behaviour refers to a person's evaluation of a specified behaviour. The Technology Acceptance Model used the attitude toward using the system. Davis identified two belief constructs, Ease of Use and Usefulness to diagnose the influence of the system characteristics on user attitude and usage. He argued that his model postulates a causal relationship between beliefs. Fishbein in his model, as opposed to Davis' model, does not take into the account the relationship that may exist between beliefs. He also states that there is a distinction in the character of beliefs as "*descriptive beliefs*" and "*inferential beliefs*". The definition of descriptive beliefs is that these beliefs are formed on the basis of directly observing the object or event. Inferential belief is defined by Davis (1986, p.

32) as beliefs that “go beyond observable phenomena”. Davis identified his Ease of Use as a descriptive belief based on a person’s own experience with the system. He argued that person may speculate beyond the experience and therefore have the influence of some inferential processes as well. He argued that Usefulness is an inferential belief in its nature since the user has to estimate the effect of the system on the job without having direct experience of using the system.

Davis (1986, p. 25) defines his model by the following structural equations:

$$EOU = \beta_{11}System + e_1$$

$$USEF = \beta_{21}System + \beta_{22}EOU + e_2$$

$$ATT = \beta_{31}EOU + \beta_{32}USEF + e_3$$

$$USE = \beta_{41}ATT + e_4$$

Where

$\beta_{11}$  = design feature

EOU = perceived ease of use

USEF = perceived usefulness

ATT = attitude toward using

USE = actual use of the system

e = random error term

“System” has been defined as a dummy variable with the values 0 for electronic mail and 1 for text editor. USE refers to intensity of system usage, EOU refers to Perceived Ease of Use, USEF refers to Perceived Usefulness and ATT refers to Attitude Toward Using of the system.

Davis has used a seven-point semantic rating scale for attitude devised by Ajzen and Fishbein (1980). The scale had six dimensions or subscales: good-bad, wise-foolish, favourable-unfavourable, beneficial-harmful, positive-negative and neutral. The

attitude scale had a Cronbach alpha reliability of 0.96 in the sample. The measurements for perceived ease of use and perceived usefulness were developed by Davies (1989). He reported high reliability of the scale with Cronbach alpha of 0.97 for perceived usefulness and 0.91 for perceived ease of use (p. 480). He used path analysis (Duncan, 1966; Duncan, Featherman, & Duncan, 1972) on his data. Davis reported that attitude had a significant impact on usage. Perceived Usefulness had a significant effect on attitude and a strong and significant effect on Use. He also reported that Ease of Use had a significant but smaller effect on Attitude and a strong effect on Usefulness. He reported that system and Ease of Use had no direct effect on usage. System did not have direct effect on Use but had a small but significant effect on Attitude. Perceived Usefulness was identified as being more important than Ease of Use in the use of the system. Davis (1989) argues that the user would be more willing to accept difficult software if it has needed functionality for his/her job rather than use software that is very easy to use but it doesn't help with their job tasks.

Davis argues that Perceived Ease of Use is supported by Bandura's research in self-efficacy. He states that self-efficacy is similar to Ease of Use in his Technology Acceptance Model. He argues that Bandura distinguishes self-efficacy from outcome judgment. The outcome judgment is linked to value of the outcome. Davis argues that Bandura's outcome judgement is similar to Perceived Usefulness (1989). He argues that self-efficacy research provides a theoretical basis to suggest that both Ease of Use and Usefulness are basic determinants of user behaviour.

Davis, Bagozzi and Warshaw (1989) replicated the TAM study with 107 users in order to predict user attitude. They measured the Usefulness, Perceived Ease of Use, Subjective Norms and related variables one hour after use of the new system and then again 14 weeks later. They reported that Perceived Usefulness strongly influenced the users' intentions, explaining more than the half of the variance in intentions at the end of week 14. Perceived Ease of Use had a small but significant effect on intentions. They also reported that attitude only partially mediated the effects of these beliefs on intention and that subjective norms had no effect on intention.

Davis (1993) further evaluated TAM in a study for the Large North American Corporation asking 112 users to rate email and word processor. Davis used the questionnaire distributed to the users (professionals and managers) to do his evaluation of the TAM. The users were asked to rate two different software systems, an electronic mail and a text editor. Each participant was asked to rate Perceived Ease of Use, Perceived Usefulness, Attitude toward Using and actual use of the system. Davies hypothesised that Perceived Ease of Use should have a significant direct effect on Usefulness. Perceived Ease of Use would have a significant positive effect on Attitude Toward Using, controlling for Perceived Usefulness. Perceived Usefulness would have a significant positive effect on Attitude Toward Using. Attitude Toward Using would have a significant effect on actual system use. He also hypothesised that characteristics of the system would indirectly influence the Ease of Use. System would not have a significant direct effect on Attitude Toward Using. System would have a significant effect on Perceived Usefulness and Perceived Ease of Use. Perceived Usefulness, Perceived Ease of Use, and system will not have significant direct effects on actual system use. In conclusion he reported that Usefulness had twice as strong an effect on use than Attitude Toward Using. In addition Usefulness had a more than four time stronger influence on attitude than Ease of Use (1993). Davis reported this as inconsistent with findings of Fishbein and Ajzen (1975). He refers to Bagozzi (1992) who also found that beliefs have an effect on intention and indirectly affect attitude.

Davis also discussed the difference between objective and subjective Ease of Use measurement. He stated that the Technology Acceptance Model measured Perceived Ease of Use whereas many other human factors models measured objective Ease of Use in a laboratory performance metrics form, such as speed of task completion and error rate (1989, p. 225). He addressed the issue of when to use which of the Ease of Use measurements, as dependant on the system type. He advised that a non-discretionary system should use the objective Ease of Use and a discretionary system a subjective one. He stated that the main determinant of the success in discretionary systems is that subjective use and therefore subjective measurement should be used. Davis also raised the importance of the question to

what extent the success or failure to achieve the goal influenced motivation. Davis excluded subjective norms from his investigation due to the fact that his experiments were performed in laboratory circumstances. However, he had argued that the same model can and should be used in non-laboratory circumstances and therefore subjective norms should be included and further researched. He argued that the Technology Acceptance Model was intended to investigate the technology acceptance processes at the organizational level as well and therefore the role of subjective norms would be very important.

Davis (1989) stated that TAM2 as a variation of the TAM model had introduced into TAM two additional constructs: perceived quality of output and anticipated enjoyment of using the system. This TAM2 model had retained a relationship between System and Usefulness. Davis argued that quality of output graphs of the system were identified as a measure of the benefit of using the system. The characteristics of the system determined the quality of the outcome charts of the system, which then influenced the perceived usefulness of the system. He also argued that according to some theorists human behaviour is influenced by both extrinsic and intrinsic motivation. He argued that many users would use computers partially intrinsically motivated so the Enjoyment construct was added to the model. Deci (1975, p. 23) defines intrinsically motivated activities as ones for which there is no apparent reward except for the activity itself. "People seem to engage in the activities for their own sake and not because they lead to an extrinsic reward." He argued that Ease of Use should influence Enjoyment and Enjoyment should increase Attitude Toward Using the system. Davis stated that System, Ease of Use and qualification do not have significant direct effect on Attitude above and beyond Enjoyment and Usefulness. All other variables affect usage only indirectly via Attitude and Usefulness. Davis' first version of an alternative model, referred to as TAM2 is shown in Figure 2-7.

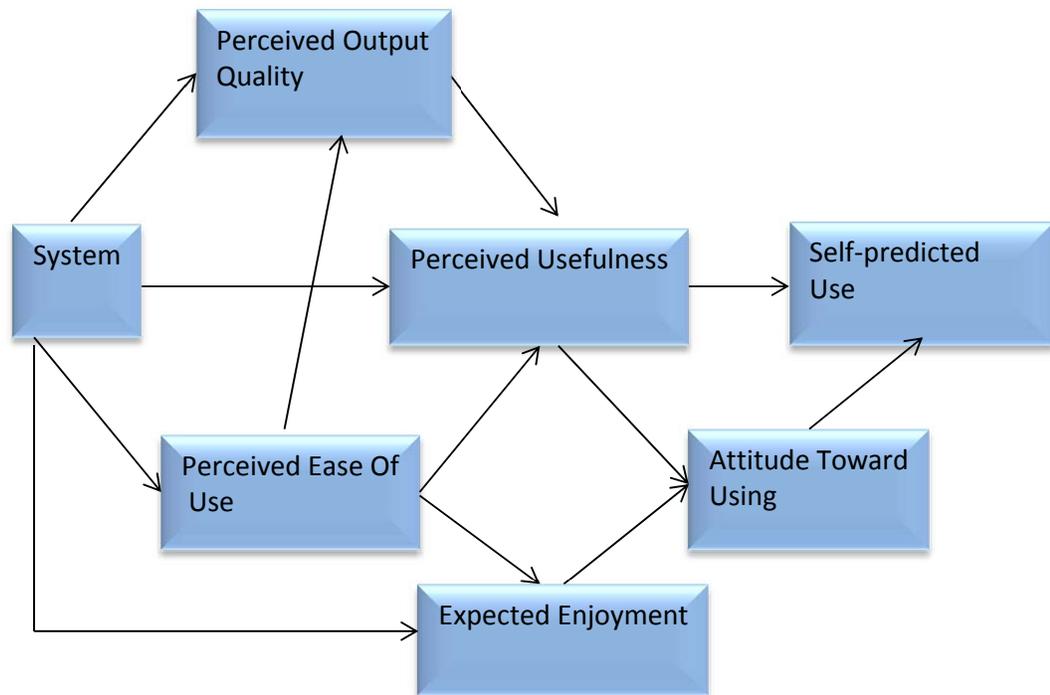


Figure 2.7. TAM2 model by Davis. (1989, p. 137)

A new extended TAM2 model was introduced by Venkatesh and Davies (2000) and included in the model the following external variables: social influence (subjective norms) and cognitive instruments (job relevance, image, quality, and result demonstrability). The definition of Perceived Ease of Use in TAM2 is as anchor (computer self-efficacy, perceptions of external control, computer anxiety, and computer playfulness) and adjustments (perceived enjoyment and objective usability). The result of their investigation explained 60% of variance of PEU ( $R^2 = 0.6$ ) and 40% -60% variance of PU ( $R^2 = 0.4$  to  $0.60$ ).

The new model included the following additional constructs: experience, subjective norm, image, job relevance, output quality, result demonstrability and voluntariness (Venkatesh & Davis, 2000). The authors defined image as the degree of enhancement in social status by use of the system; job relevance as the user's perception as to how much the system is relevant to their job; output quality they defined as the perception of the user as to how well the system performs the job

task; result demonstrability they defined as the tangibility of the result of using the system and voluntariness as the perception of how much the adoption of the system was voluntary. The Technology Acceptance Model TAM2 is shown in Figure 2-8.

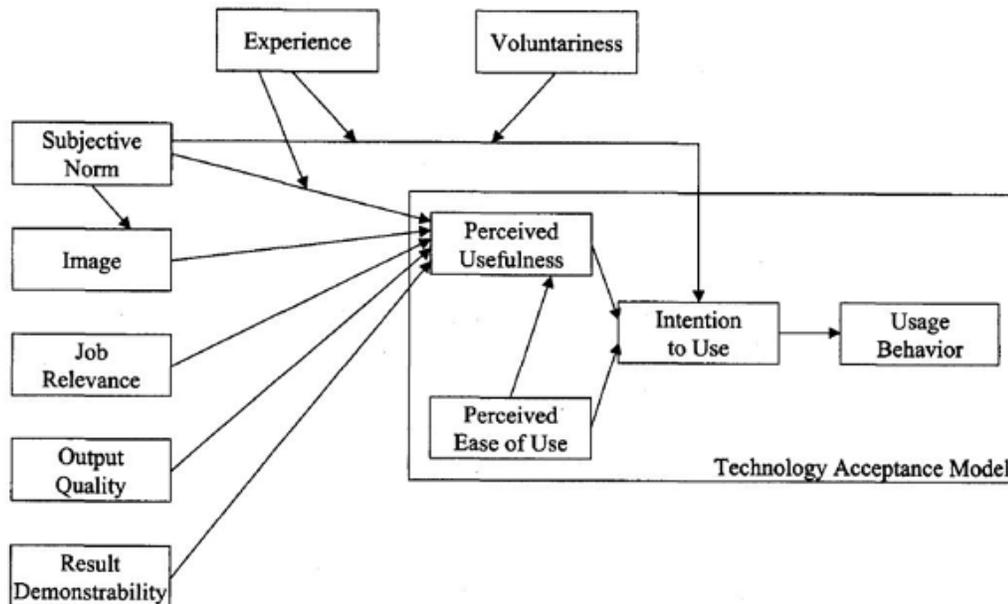


Figure 2.8. Technology Acceptance Model TAM2 (Venkatesh & Davis, 2000). Reprinted with permission.

Davis developed the first technology acceptance model which has been used widely in information systems and management for the last three decades. His model provides a tool for better understanding of factors and constructs that define technology acceptance. Its strength is that it can be used across a broad range of technologies and users. It is simple to use in comparison with other models and at the same time based on sound theory. Its simplicity is defined by having only two constructs, Ease of Use and Usefulness. His conceptual model defined Ease of Use and Usefulness as constructs that affect attitude towards using the system. The attitude would then impact on, and determining the users' behaviour towards usage of the system. His motivational model reflects the influence of the design choices on user motivation to accept the technology. The Technology Acceptance

Model is considerably less general than the Theory of Reasoned Action, since it has been designed to apply only to explain computer usage behaviour. It is specifically well tailored for modelling computer usage because it is based on several decades of information systems research (Davis, Bagozzi, & Warshaw, 1989).

The TAM has been used in different IS systems with different users and extended with different constructs. The attempt to define a more general and unified model resulted in a new UTAUT model. This Unified Theory of Acceptance and Use of Technology model (UTAUT) is explained in the following section.

### **2.2.2. UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY MODEL (UTAUT) AND UTAUT2.**

The UTAUT (Venkatesh, Morris, Davis, & Davies, 2003) model has been proposed as a model with an objective to further explain user intention to use the technology and technology usage. It was developed in order to unify the previous models used to explain user acceptance of the technology in an Information Systems field. The review of the following eight models: technology acceptance model, theory of reasoned action, theory of planned behaviour, motivational theory, combined theory of planned behaviour and technology acceptance model, model of PC utilisation, innovation diffusion theory and social cognitive theory, were taken into the consideration. The new unified theory defined four key constructs of using intention and behaviour. They are: performance expectancy, effort expectancy, social influence and facilitating conditions (Venkatesh, Morris, Davis, & Davies, 2003). The authors argued that these constructs were the determinants of usage intention and behaviour of the user. In addition to four constructs the authors used the following four parameters to moderate the impact of the constructs: age, gender, voluntariness and previous experience. The authors empirically validated this model in a longitudinal study and the result explained 70% of the variance of the intention to use the technology. They used data from four organizations over a six month period. They found that eight models explained between 17 and 53

percent of the variance of user intention to use the technology and therefore their new model had outperformed the other eight.

Venkatesh (2000) has carried out further extension of the model by investigating external variables of PEU (Perceived Ease of Use) such as: Computer Self-Efficacy (CSE), Perception of External Control, Computer Anxiety, Computer Playfulness, Perceived Enjoyment and Objective Usability. In his investigation he used subject norms (defined as a person's belief that most of his important others think he should (or should not) perform the behaviour in question (Ajzen & Fishbein, 1980), and actual usage of the system (rather than self-reported usage). He also has placed the investigation in a working environment.

Figure 2-7 shows a diagrammatic representation of the concept of a unified theory of acceptance and use of technology (UTAUT) proposed by Venkatesh, Morris, Davis and Davies (2003).

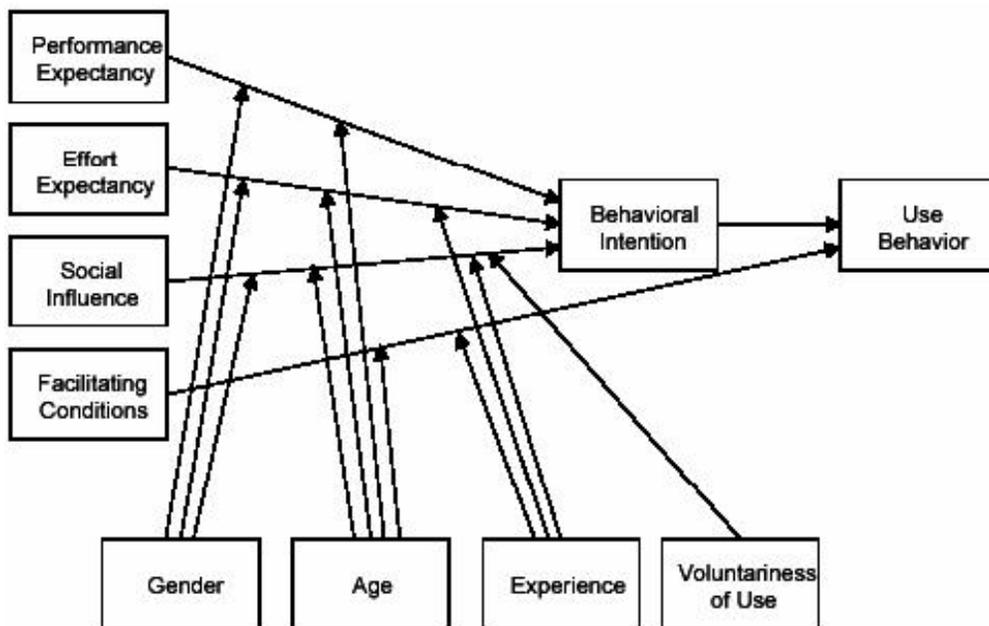


Figure 2-7. Unified Theory of Acceptance and Use of Technology model (UTAUT). Reprinted with permission.

Venkatesh, Thong and Xu (2012) proposed a new extended model UTAUT2 in order to study technology acceptance in a consumer environment. This model incorporates three new constructs: hedonic motivation, price value and habit. Their model also includes the following moderating constructs: age, gender and experience. In their conclusion they state that hedonic motivation was moderated by all three moderators, age, gender and experience. Price value was moderated by age and gender and habit was moderated by individual differences. The study confirmed that hedonic motivation, price value and habit had important influences on technology use within the UTAUT2 model and consumer acceptance contexts. Their results showed that the extension proposed in the new UTAUT2 model had explained more behavioural intention than the UTAUT model. They reported an increase in the variance explained in behavioural intention from 56 to 74 percent and technology use variance from 40 to 52 percent.

Many researchers have used the UTAUT model as a basic model in their research. The model has been used as an integrated model in new contexts, with new users or in new cultural settings. New contexts included health information systems (Chang, Hwang, Hung, & Li, 2007) and new users as healthcare professionals (Yi, Jackson, Park, & Probst, 2006) and new cultural settings in China and India. Other researchers have added new constructs and included them in the UTAUT model in order to better predict user technology acceptance. The main criticism of replication and application and extension of the UTAUT model is that most researchers have been using only a subset of constructs from the original model and also often reducing (or not employing) the moderators.

### **2.2.3. TECHNOLOGY ACCEPTANCE MODEL TAM3**

The first version of the TAM3 model was introduced by Davis (1986, 1989, 1993). He extended his original TAM2 model by representing ease of use and quality of output graphs as task specific. The reasoning behind this is that the nature of the task may influence Perception of Ease of Use or quality of outputs; therefore specific tasks to a job are added. Davis argues that the Perceived Usefulness of a

system was determined, by a system perceived benefit, relative to the task and the importance of that task to the person. Therefore, the model should achieve the "fit" between the system's characteristics and the individuals and their job requirements. Davis used in his experiment two types of graphs: numeric (e.g., line graphs, pie charts, bar charts etc.) and non-numeric (diagrams, drawings, flowcharts etc.) Davis concluded that no variables above and beyond enjoyment and usefulness have a direct influence on attitude, and no variables other than attitude and usefulness directly influence usage. He argued that TAM3 represented a framework for carrying out a finer analysis of system functionality and a better fit between the system and user. He also argues that the model is powerful enough to identify similar needs of the users who may need specific systems. Figure 2-8 displays the Technology Acceptance Model TAM3 by Davis.

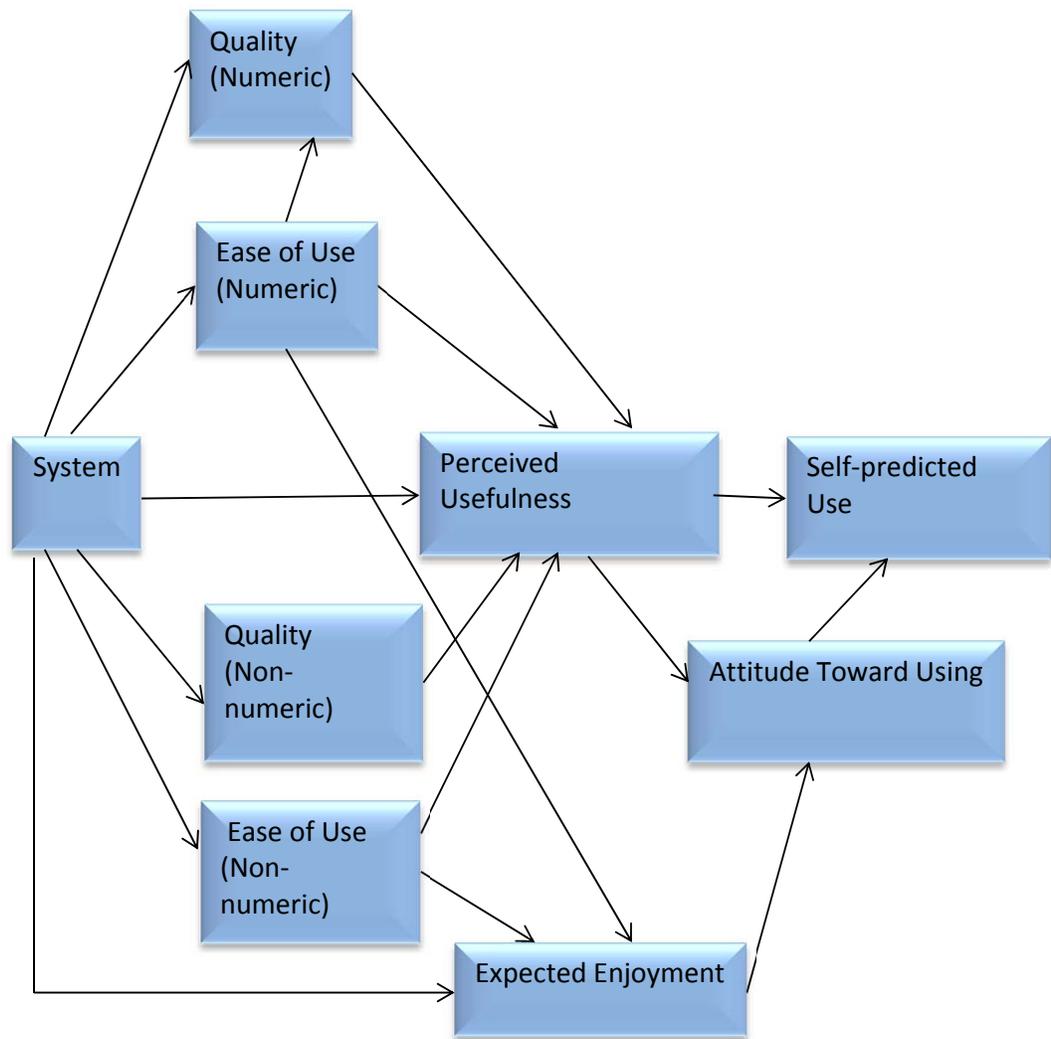


Figure 2-8. Davis's Technology Acceptance Model TAM3 parameters (1986, p. 204).

In addition to constructs identified and used by Davis (1986) in the previous technology acceptance models, such as: Experience, Subjective Norms, Image, Job Relevance, Output Quality, Result Demonstrability, Voluntariness, Computer Self-Efficacy, Performance Expectancy, Ease of Use, Usefulness, Perceived Enjoyment and Social Influences the new constructs are added in the new TAM3 model developed by Venkatesh and Bala (n.d.). New constructs added in the TAM3 were: Computer Anxiety, Computer Playfulness, Effort Expectancy, Objective Usability and Perception of External Control. Venkatesh and Bala defined Computer Anxiety as

user apprehension or fear when faced with use of the technology. They defined Computer Playfulness as degree of cognitive spontaneity with the system used. Effort Expectancy was defined as the degree of ease associated with the system use, whilst Objective Usability was defined as the level of effort required to complete the task compared to other systems. The final additional construct in the TAM3 model, Perception of External Control, was defined as seeing the definition of facilitating conditions. The TAM3 was developed with a focus on interventions. This concept is presented in Figure 2.9.

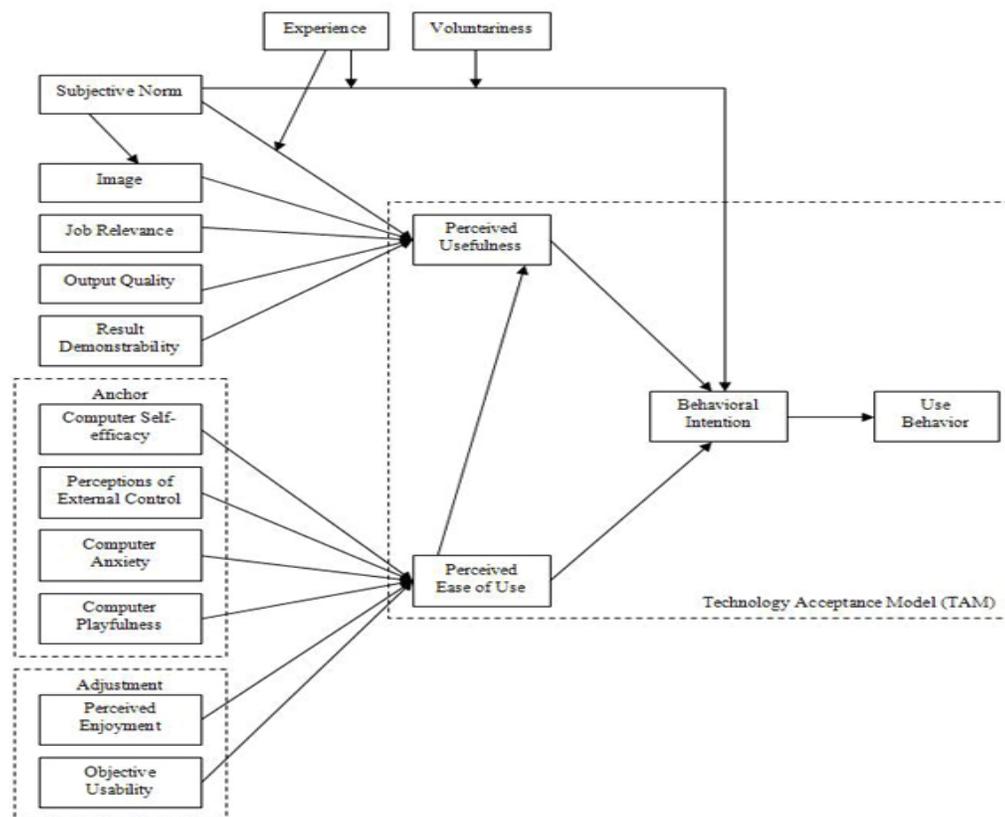


Figure 2-9. Technology Acceptance Model with the focus on interventions TAM3 (Venkatesh & Bala). Reprinted with permission.

In summary, this section has covered Venkatesh et al. UTAUT and UTAUT2 models and the new TAM3 model proposed by Venkatesh and Bala. It has added new constructs to the model with the aim of gaining a better insight and understanding of technology acceptance models.

The next section illustrates the chronological development of TAM models and presents some applications and evaluations of TAM models in different settings and with different users.

### **2.3. APPLICATION AND VALIDATION OF TAM**

Many authors have used the Technology Acceptance Model in different environments, with different users, and with different objectives. In this section a review of the development and use of the Technology Acceptance Model is outlined. It illustrates the sample of chronological model development and evaluation from 1989 (its introduction) to the present 2012, when the latest TAM3 model was introduced.

The chronological development of the TAM is based on research by Lee et al. (2003) who presented the results of a comprehensive investigation into TAM history, its findings and the future development. Table 2.1 shows the chronological order of TAM through development, validation and extension phases of the model.

Table 2.1.

*The Historical Development of the Technology Acceptance Model from 1989 to 2003*

Model Development	Authors and year published	Area of Use	Findings
<b><i>Introduction of the TAM model</i></b>	(Davis, 1986)	Introduction of the model	Definition of the TAM with two dimensions: Perceived Usefulness (PU) and Perceived Ease of Use (PEU)
	(Davis, Bagozzi, & Warshaw, 1989)	Email and text editor adoption	Provided an explanation of the determinants of computer acceptance
	(Bagozzi, Davis, & Warshaw, 1992)	The investigation in the Computing learning	In contemplating to use new technology people form a multidimensional attitude toward learning. The three distinct dimensions are identified: attitudes toward failure, attitudes toward success, and the process of trying to learn
	(Davis, 1993)	Replication of previous (1989) study using email and text editor adoption	TAM successfully explained the adoption of both technologies ( $R^2=0.36$ ), PU was 50% more influential than PEU
	(Sambamurthy & Chin, 1994)	GDSS use investigation	The ratio PU/PEU successfully predicted group attitude to GDSS use
	(Subramanian, 1994)	Replication of the TAM with two mailing systems	TAM variables showed results consistent with other studies
	(Hubona & Cheney, 1994)	Compared the TAM and Theory of Planned Behaviour (TPB)	TAM is simpler, easier to use and more powerful to explain user acceptance of the

Model Development	Authors and year published	Area of Use	Findings
			technology.
	(Taylor & Todd, 1995a)	Compared TAM, TPB and Decomposed TPB	A TPB and decomposed TPB better explained use intention and use, than TAM
	(Taylor & Todd, 1995)	Examination of broader environmental factors including emotions, habit, organizational and societal acceptance. Computer Information Resource Centre	Found that subjective norm is better predictor of intention with inexperienced participants explaining 34% ( $R^2=0.34$ ) of the variance in behaviour, 52% ( $R^2=0.52$ ) of variance in intention and 73% ( $R^2=0.73$ ) of the variance in attitude
<b>Validation</b>	(Adams, Nelson, & Todd, 1992)	Inclusion of culture, gender, task, user type and IS type variables	The need for examination of gender, culture, task and IS type is established.
	(Segars & Grover, 1993)	Three factor TAM model with effectiveness	Found the results contrary to previous researcher; found that three factor model and not two is more significant
	(Szajna, 1994)	Investigated predictive validity of TAM on Data Base Management Systems DBMS	Found good predictive validity for both PU and PEU
	(Venkatesh & Davis, 1994)	Investigation into the interrelationship between ease of use and self-efficacy on two different technologies: email and gopher with the training over time.	Found no significant differences between perceived ease of use of different systems before training and significant difference after the training
	(Hendrickson &	Investigation into	Found TAM to be reliable and

Model Development	Authors and year published	Area of Use	Findings
	Latta, 1996) (Hendrickson, Massey, & Cronan, 1993)	reliability of PU and PEU scales	valid in the terms of test-retest analysis
	(Chin & Todd, 1995)	Performed structural equation modelling analysis	Found contrary to Segars and Grover (1993) that there is no rationale to separate PU into two dimensions
<i><b>Additions</b></i>	(Igbaria & Iivari, 1995)	Investigation of the effects of organizational factors: training, computing support, managerial support	Managerial support, computer support and training affect both PU and PEU
	(Straub, 1994)	TAM applied in two countries with different culture	Culture is important in attitude toward choice of media
	(Gefen & Straub, 1997)	The effect of gender difference on IS acceptance	The gender influence moderates the effects of both PU and PEU males are affected by PU and females by PEU and subjective norm.
	(Agarwal & Prasad, 1999)	TAM extended with five individual variables	Found that relationship between training and PU and prior experience, technology role, tenure in workplace, education, prior experience and PEU were successfully predicted
	(Karahanna & Straub, 1999a)	Investigation into potential adopter's and current user's continuous IS adoption	Found that subjective norms affect the adoption intention of potential adopters and attitudes affect current users.

Model Development	Authors and year published	Area of Use	Findings
	(Gefen & Straub, 2000)	The influence of task type	PEU responded differently according to the type task
	(Karahanna & Limayem, 2000)	Two technology study (e-mail and Voice-mail)	PU did not influence e-mail usage but social influence did and the reverse in the case of voice mail.
	(Ridings & Gefen, 2000)	Applied TAM with old IS user and new IS user in parallel	PU increases the preference for new IS adoption, PEU of the new and old IS are the determinant of PU of new IS and old IS
	(Moon & Kim, 2001)	TAM applied in Internet context with entertainment task and work task differentiation	Internet usage depends on type task. Perceived playfulness the most significant for entertainment and PU for work related tasks.
<b>Further development</b>	(Venkatesh & Davis, 2000)	TAM2 introduction of external variables of PU social influence	Explained variance of PEU is $R^2 = 0.6$ and PU $R^2 = 0.4$ to $0.60$
	(Venkatesh, 2000)	TAM2 External variables of PEU such as: computer self-efficacy, perception of external control, computer anxiety, and computer playfulness and perceived enjoyment and objective usability	Used Subject Norms and actual usage. The proposed model was strongly supported and explained 60% of the variance ( $R^2 = 0.6$ )
	(Venkatesh, Speier, & Morris, 2002)	The development of an Integrated Model which specifically investigating the influence of pre-	Found that the Integrated Model is better predictor of user behaviour than the existing model

Model Development	Authors and year published	Area of Use	Findings
		training and training environment interventions ( user acceptance enablers)	
	(Dishaw, Strong, & Bandy, 2002)	Investigation into models for software utilisation choices	Proposed new model TAM/TTF (Task-technology fit) (Godhue, 1995) with CSE (computer self-efficacy)
	(Yi & Hwang, 2003)	Investigation into web-based information systems acceptance	The model included self-efficacy, enjoyment, learning goal orientation. The result largely supports the model.

Adapted from Lee et al. (2003)

The steady development of the TAM over last 25 years started with Davis's basic model in 1986 defining two factors (PU and PEU) that defined users' technology acceptance. The basic model has been developed over time to the following extended models TAM2, UTAUT, UTAUT2, including multiple models (TAM/TTR/CSE- TAM/Theory of Trying/Computer self-efficacy) with a multitude of additional factors/constructs. One of the major limitations of the TAM in the early stages was the fact that it did not include any extrinsic factors and did not account for social influences in the adoption of a new information systems and technology. The term "external " has been used by Ajzen and Fishbein (1980) to acknowledge that other outside factors might be affecting relationships between beliefs, attitude, intentions and behaviour. According to Davies (1993), the future development of the TAM model should take into account personal beliefs and subject forms based on the perception of what behaviour is expected to be performed in the particular situation. Davies also suggested some other factors that could be included in TAM such as: experience, top management support, user involvement and task complexity.

Davies, Bagozzi and Warshaw (1989) in their study compared the TAM with the theory of reasoned action in order to investigate how well the models would

predict and explain future user behaviour. They gave the users a very short exposure to the new system and the users then performed simple measures. Their study simulated the scenario of trialling a new system or prototype in the organization. The study gathered data from 107 full-time MBA students in their first year. Data were collected at two different times; the first was at first exposure to the system and the second 14 weeks later. They found in their study results, that both models had explained a significant proportion of the variance in intentions with TRA explaining 26-32% and TAM 47-51%, respectively, between the first or second data collections. Both models suggested behavioural intention as the major determinant of usage behaviour. Usage behaviour is predictable from behavioural intention and any other factor that influences user behaviour would do it indirectly through behavioural intention. In terms of individual determinants of Behavioural Intention, they found that Attitude had a strong influence on Behavioural Intention, and Subject Norms had no significant influence within TRA. Within the TAM results, they found that Usefulness had a strong effect on Behaviour but Attitude had less influence. They also found, that contrary to TRA, Beliefs had a significant direct effect on Behavioural Intention and that Ease of Use had a significant direct effect on Behavioural Intention. They also found out that Usefulness had significant explanatory power beyond Attitude and Subject Norms. The lack of significant Subject Norms and Behavioural Intention effect was different from results of previous research, emphasizing how important it is for the top management to support the user. They explain this effect with the fact that subject norms scales were particularly weak from a psychometric point of view and in need of more sophisticated assessment methods.

In summary David, Bagozzi, and Warsaw (1989) had compared TAM with TRA in their study and concluded that people's computer use, could be predicted from their Intentions, that Usefulness is a major determinant of Intentions to use computers and Perceived Ease of Use is a significant secondary determinant of Intention (p. 997). In 1992, Bagozzi et al., carried out an investigation into computer learning defined by three attitudes: attitude towards success, attitude toward

failure and attitude toward the process of goal pursuit. They based the investigation on the Theory of Trying model.

Sambamurthy and Chin (1994) used TAM in a GDSS use investigation and replicated TAM with two mailing systems. At the same time, some authors compared the TAM model with TPB (Hubona & Cheney, 1994), and TAM with TPB and Decomposed TPB (Taylor & Todd, 1995a).

Other researchers have extended TAM by adding and investigating different constructs. It often happened they added new constructs in order to explain some unexpected results (Silva, 2007). Taylor and Todd included the following environmental constructs: emotions, habit, organizational and societal factors. They found that Subjective Norms is a better predictor of intention with inexperienced participants explaining 73% of the variance in attitude. Other researchers included in their studies; gender, task, user type and information system type (Adams, Nelson, & Todd, 1992) and Gefen and Straub (1997), effectiveness (Segars & Grover, 1993), training (Venkatesh & Davis, 1994), experience and education (Agarwal & Prasad, 1999), organizational factors such as computing support, managerial support (Igarria & Igarria, 1995), task type (Gefen & Straub, 2000) and perceived playfulness (Moon & Kim, 2001). Investigations into user types were by Karahanna and Straub (1999a) and Ridings and Gefen (2000). Venkatesh and Davies (2000) investigated voluntariness. Bagozzi, Davies and Warshaw (1992) investigated the role of learning. Self-efficacy, enjoyment and learning goal orientation were investigated by Yi and Hwang (2003), and personal innovativeness by Agarwal and Prasad (1998).

Bagozzi and Warshaw (1990) investigated the role of learning to use a computer. They used the Theory of Trying (TT) in the process of their investigation. The Theory of Trying conceptualises computer learning as a goal determined by three attitude components: attitude towards success, attitude towards failure and attitude toward the process of goal pursuit. It identified that computer use is influenced by two factors: the intention to using the systems and the degree of trying to learn. The results of the study suggested that changing people's attitudes toward the

process of learning may improve their motivation to learn. Computer learning is often characterised as “learning by doing” and as “hands-on learning” in which learners try to do things before reading the instructions. The findings indicated that TAM and TRA has performed significantly less effectively than TT in the prediction of intention to try and trying.

Yi and Hwang (2003) extended the technology acceptance model by incorporating the motivation variables of Self-Efficacy, Enjoyment, and Learning Goal Orientation. The extended model has been used in the prediction of web-based information systems use. The results largely support the proposed model and put emphasis on the importance of Self-Efficacy, Enjoyment and Learning Goal Orientation in the process of finding the actual use of the system. The investigation of Geffen and Straub (1997) showed that perceived attributes of a system can differ between genders. The Perception of the PU of the system was reported as being different between genders but the actual use of the system was reported as not being affected by gender.

Straub (1994) and Straub et al. (1997) explored culture aspects in the use of the TAM in their studies. They argued that the model has not performed well in different cultural settings. Straub (1994) investigated the performance of the model in Japan and Switzerland. He used the model with airline employees using new software compared his results with a similar study conducted in the USA. He stated that the model has performed well in predicting the use of software in Switzerland but not so in Japan. The differences he argued should be attributed to the cultural differences between the two countries. Some authors challenged the use of TAM outside developed countries. They argued that TAM has not been tested outside of developed countries and may not be appropriate for use as such in developing countries (Anandarajan, Igbaria, & Anakwe, 2000).

The development of an Integrated Model by Venkatesh et al., (2002) which specifically investigated the influence of pre-training and training environment, followed. They found that the Integrated Model is a better predictor of user behaviour than the existing model. Further investigation has resulted in a

combination of models being used. Dishaw, Strong, and Bandy (2002) proposed a new model combining TAM with task-technology fit (TTF) (Godhue, 1995), and with computer self-efficacy (CSE) (Compeau & Higgins, 1995). Geffen and Straub used SPIR added to TAM for their investigation. SPIR is a combination of SP (perceived social presence, i.e., the sense of human contact in a medium) and IR (the information richness of the medium) to become the diffusion model. The diffusion model that was originally developed by Bass (1969) describes the process of new products adoption as an interaction between users and potential users. It has been widely used in forecasting and especially in product and technology forecasting.

The number of added constructs in the TAM model has increased over time, typically in order to explain the differences in the research findings. The items for measuring Perceived Usefulness have increased from six to fifty, and for Perceived Ease of Use from six to thirty eight (Adams, Nelson, & Todd, 1992).

TAM developments and application from 2005 to 2012 are shown in Table 2.2.

Table 2.2.

*Development of New Technology Acceptance Models from 2005-2012*

New TAM development	Authors and year published	Area of Use and Research	Findings
	(Ma, Andersson, & Streith, 2005)	Investigated student teacher perceptions of technology use	PU has significant effect on intention to use, PEU only indirect effect, their subjective norm did not have effect on intention to use
	(Bhattacharjee & Sanford, 2006)	Investigation into external influence processes for information technology acceptance	Influence processes introduced as a tool to motivate IT acceptance, specify influence strategies and need for customizing it.
	(Bhattacharjee & Sanford, 2006)	Investigation into two alternative influence processes	ELM (elaboration-likelihood model) is used with seven constructs
	(Venkatesh,	Comparison of the two	Social psychology-based

New TAM development	Authors and year published	Area of Use and Research	Findings
	Davis, & Morris, 2007)	methods: theory of planned behaviour TPB and job satisfaction	technology adoption research focused on interventions, contingencies, and alternative theoretical perspectives
	(Silva, 2007)	Paper explores what it is to know, what is the theory and what it means to be scientific in the context of TAM	The philosophical foundations of TAM opened for scrutiny and evaluation within criteria in the post-positivistic views of science
	(Bagozzi, 2007)	The critique of TAM with identifying limitations.	New model proposed.
	(Devaraj, Easley, & Crant, 2008)	Five Factor Model	FFM can be useful predictor of user's attitude
	(Kim, Kim, & Kim, 2010)	Investigation into adoption of social media	Development of social media adoption model added constructs perceived enjoyment, and intention to use
	(Dwivedi, Mustafee, Carter, & Williams, 2010)	Comparison between TAM and UTAUT	UTAUT used more than TAM
	(Kemp, 2011)	Investigation into student intention to use 3D immersive learning tools in an online learning classroom.	Identified gender differences in attitudes toward acceptance
	(Venkatesh & Bala)	TAM 3 Venkatesh and Bala	Developed TAM 3 with the focus on interventions.
	(Venkatesh, Thong, & Xu,	New extended model UTAUT2 developed	Investigated technology acceptance in a consumer

New TAM development	Authors and year published	Area of Use and Research	Findings
	2012)		environment. This model incorporates three new constructs: hedonic motivation, price value and habit.

TAM has been mostly investigated by researchers as a “framework for explaining decision making by individual persons... (Bagozzi, 2007, p. 247) . Decision and usage were initiated by “individual reactions to using information technology” (Venkatesh, Morris, Davis, & Davies, 2003, p. 427). When the social influence processes are introduced into TAM it has been “in a limited sense in either a construct or force on the decision maker” (Bagozzi, 2007, p. 247). According to Bagozzi, TAM research has not taken adequately into account the influence of group, cultural, or social aspect of decision making and usage. Venkatesh, Morris and Davis (2007) suggested that TAM research should focus on social psychology-based technology adoption research. A similar statement came from Malhotra and Galleta (1999) that TAM is incomplete because it does not take into account social influence in the adoption of new information systems. They proposed a new model of Psychological Attachment which represents the perceived fit of the used system to the user’s value system. They specify that Psychological Attachment is highest when internalization is happening and at the lowest in the case of compliance only.

Bagozzi (2007) has identified three aspects of goal decision making: achieving the goal, failing to achieve the goal, and then expressed the evaluations (positive or negative emotions) of each aspect. He defined the decision making process as “the sequence of consider-imagine-appraise-decide” (2007, p. 249). He proposed one universal approach to decision making and a new paradigm. The core of the new paradigm of decision making consists of: goal desire, goal intention, action desire, action intention. With the addition of cause or constraints and their effects, it represented fully deterministic processes which captured basic stages in decision

making. His model strived to accommodate any decision making process and therefore included user acceptance decision as well.

Devaraj et al. (2008) added user personality examination with the Five-Factor Model (FFM model) incorporated into TAM. They found that the FFM personality dimension can be useful in users' attitude predictions and reported strong support relationships between intention to use the system and use of the system. The personality dimensions used in FFM were: conscientiousness, extraversion, neuroticism, openness and agreeableness. Conscientiousness has been defined as "the degree of organization, persistence and motivation in goal-directed behaviour", extraversion has been defined as "being sociable, gregarious and ambitious", neuroticism as "emotional instability characterised by insecurity, anxiousness and hostility", openness as "openness to experience, represented by flexibility of thought and tolerance of new ideas" and agreeableness as "represented by compassionate interpersonal orientation" (Devaraj, Easley, & Crant, 2008, p. 94).

Kim et al., (2010) developed a social media adoption model based on two constructs of TAM and two additional constructs (Perceived Enjoyment and Intention to Use). They found that Perceived Usefulness, Perceived Enjoyment and Social Influence are important determinants of social media adoption. They suggested that Perceived Enjoyment is important and may have a greater impact than PU and PEU on intention to adopt the social media, and that individual perception of PU, PEU and Perceived Enjoyment may be attributed to the social influences of social networks.

Ma et al., (2005) found that PU had a direct significant effect on the intention of student teachers to use computers. This is comparable with prior studies in different contexts and technologies according to Mahmood et al., (2001) and Legris et al., (2003). A possible explanation is that computers help teachers to improve their performance and may therefore motivate their intention to use computer technology. PEU was found to have an indirect significant effect on intention through PU but the teacher's subjective norm did not have any effect. Venkatesh

and Davis (2000) have found that the subjective norm had a significant effect on intention to use in a mandatory setting but no effect in a voluntary setting.

Bhattacharjee and Sanford (2006) introduced influence processes and their effect on motivation to information technology acceptance. They proposed influence strategies and the need to customize the strategies to the specific needs of users. The elaboration likelihood model (ELM) used had seven constructs: Usefulness, Attitude, Acceptance Intention, Argument Quality, Source Credibility, User Expertise and Job Relevance. This model was developed out of the need to address the shortcomings of previous models. Decomposed Theory of Planned Behaviour (DTPB) and UTAUT both acknowledged that social norms may influence user perception but they did not explain why and how. TAM also had recognized that the external constructs may influence user perception but did not specify any. Dwivedi et al., (2010) performed a comparison between the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and use of Technology (UTAUT). Their findings suggested that researchers were shifting focus from TAM to UTAUT in their research.

Kemp in his study (2011) investigated student intention to use 3D immersive learning tools in an online learning classroom. He used the Venkatesh, Morris, Davis and Davis (2003) unified theory of acceptance and use of technology model (UTAUT) and modified it for online learners with changes recommended by Marchewka, Liu, and Kostiwa (2007). Venkatesh et al., (2003) in their UTAUT unified theory studied relationships between the Perceived Effectiveness of the technology and the moderators such as experience and demographics. Kemp (2011) found in his study that the results corresponded with previous studies for correlation between Attitude and Intention to use the system. He also showed how a user's intention was moderated by user characteristics such as gender, age, vision problems and experience. He found that the effects of moderating factors were significant for Second life learning. He also found that age, vision problems, gaming frequency and experience were closely related to intention to use tools. He found out that there is no significant correlation between Voluntariness of the tool and Intention to use. Kemp found that Behavioural Intention correlated directly with

the following moderators: age, gender and experience. He also found that female showed weaker correlation between Social Influences and Behavioural Intention but stronger and significant correlations in Attitude and Self-Efficacy. Male students were more interested in the system impact on the grades (Usefulness) and were less impacted by Performance Expectancy. In regard to age, he found that older students showed a stronger Behavioural Intention to use the tool based on Performance Expectancies, Attitude and Self-Efficacy. He stated that student Attitude toward using the tool became more prominent as they grew older. He also stated that the more experience users have with the technology the greater their willingness to use new technology.

In summary, TAM has been used by many researchers in different ways. Some researchers worked on the development of new models incorporating technology acceptance with other models. Others proposed using the existing model with additional constructs. One group of researchers focused on using the same model but in different business environments or with different users. Taylor and Todd integrated TAM with the Theory of Planned Behaviour (TPB) (1995a), Venkatesh and Davies proposed TAM2 (2000), Venkatesh et al. (2003), developed the Unified Theory of Acceptance and Use of Technology, Dishaw et al., (2002) developed a combined TAM/TTF (Task Technology Fit) model, Lin et al., (2007) integrated technology readiness and TAM into TRAM, Battacherjee and Sanford (2006) developed an elaboration likelihood model, and Venkatesh and Bala introduced TAM3. New constructs have been added by many researchers. Agarwal and Prasad (1998) added compatibility to the model; Agarwal and Karahanna (2000) added playfulness and personal innovativeness to the model; Venkatesh and Davis added subjective norms to Davis's original TAM model; peer influence was integrated into the model by Chau and Hu (2002); the trust construct was added by Gefen, Karahanna, and Straub (2003); and Wu and Chen (2005) added trust in online systems. In addition, Lee used TAM and TPB, perceived risk and perceived benefit in online banking systems.

A meta-analysis of TAM implementation has been undertaken by many authors; including Hwang and Wu (1990), Hwang (1996), Ma and Liu (2004), Mahmood et al.

(2001), Marakas et al. (2010), and King and He (2006). The meta-analysis has been recommended by Rosenthal (1991) and Hunter Schmidt (1990) as being superior to literature reviews; and less subjective (King & He, 2006, p. 2). King and He in their meta-analysis outlined several important findings; they confirmed the profound influence of perceived usefulness and the high reliability of perceived usefulness and behavioural intention. In their meta-analysis, they did not mention any TAM studies deployed in education, rather than students used as surrogate for professionals. The meta-analysis was based on 88 empirical TAM studies.

A meta-analysis conducted by Ma and Liu (2004) was based on 26 empirical studies with the objective to combine the empirical evidence. They found that correlations between perceived usefulness and acceptance and perceived usefulness and perceived ease of use were reasonably strong. The relationship between perceived ease of use and acceptance was weak.

Marakas et al., (2010) aimed in their study to develop a preliminary framework to describe information technologies. Their focus in this TAM meta-analysis was to identify potential grouping solutions. Their result outlined 10 potential grouping solutions; and their meta-analysis has shown that out of 200 randomly selected studies only 26 were undertaken to investigate education and course delivery, making it only 13% out of all analysed studies. Their identified groupings are shown in Table 2.3.

Table 2.3.

*The Technology Cluster With Their Associated Labels*

Cluster Label	Number of studies	Description and Examples
Computers, operating systems and basic software	11	Computers in general
E-business and online applications	48	Technologies related to online services
Communication and collaboration	24	Email, collaborative software etc.
Commercial mobile services	4	Applications based on mobile platform
Healthcare technologies	13	Medical record systems, web sites, telemedicine
Functional applications	15	Technologies for specific functions in industry
Mobile infrastructure	17	Adoption of mobile platforms technologies
Internet infrastructure	20	Technologies for internet infrastructure
Development tools and enterprise systems	22	Software development tools and large scale enterprise systems
Education and course delivery	26	Web-based learning technologies, online teaching and course delivery, course management systems (Blackboard, WebCT), mobile learning, etc.

Adapted from Marakas et al., (2010, p. 7)

The review of the TAM investigations in education and course delivery is presented in Section 2.4.

#### **2.4. TECHNOLOGY ACCEPTANCE MODEL USE IN EDUCATION**

The Technology Acceptance Model has been used in education in order to establish the acceptance of technologies and in particular the different software in use in educational environments.

Miller and Khera (2010) investigated the elements of user acceptance of technology by using a digital library system in developing countries. They argued that the high price of journal subscription has impacted on researchers in developing countries and the digital library system will make it easier for them to have access to current knowledge. The research was undertaken at the agricultural universities in two countries, Kenya and Peru. They investigated factors that impacted on the adoption of technology and compared findings between the two countries. They found that TAM worked well in explaining the factors of usage. Perceived Usefulness was a main predictor of intent to use the digital library. They argued that relevance was major driver of Perceived Usefulness. The comparison between the two cultures identified that Relevance, Trust and Ease of Access were consistent predictors of Perceived Usefulness. They also identified that the difference in social norms, domain knowledge, visibility and self-efficacy have been predictors at only one site. They identified that TAM used in developed countries must be guided by the specific requirements of local cultures and circumstances, rather than by the overall performance of TAM in developed countries.

There are many studies specifically investigating teachers' attitudes toward technology. The argument for the importance of the teacher's attitude is explained by the fact that the success of any technology implementation in education depends strongly on the teacher's attitude. Research suggests that if teachers believe that technology is not beneficial for them or their students they will resist the technology's implementation into their program (Askar & Umay, 2001). The importance of the teacher's attitude, whether positive or negative, towards technology is that this attitude reflects on the students' perception of the importance of the technology (Teo, 2006). Yildirim (2000) also found that teachers who used the computer more tended to develop positive attitudes and further promote technology in their classrooms.

Research has shown that Attitude toward the Intention to Use will predict the use itself, and therefore, investigation into computer attitude as a major predictor of computer use is important (Myers & Halpin, 2002). Huang and Liaw (2005) stated that the extent to which educational technology will be implemented completely

depends on teachers having a positive attitude. However, computer attitudes are influenced by many different constructs. Different researchers who have investigated different aspects of computer attitudes include: Perceived Usefulness by Davis, Computer Confidence and Anxiety by Rovai and Childress (2002), and Training and Role of Learning by Bagozzi, Davies and Warshaw (1992). Bagozzi and Warshaw (1990) investigated the role of learning to use the computer. They identified that the use of the computer was influenced by two factors: the Intention to use the system and the degree of Trying to Learn. The results suggest that changing people's attitude toward the process of learning may improve their motivation to learn. Computer learning is often characterised as "learning by doing" and hands on learning in which learner try to do things before reading the instructions. Yi and Hwang (2003) investigated Attitude toward using the technology by incorporating the motivation variables of Self-Efficacy, Enjoyment, and Learning Goal Orientation. The extended model has been used in prediction of web-based information systems use. The results largely support the proposed model and puts emphasis on the importance of Self-Efficacy, Enjoyment and Learning Goal Orientation in the process of finding the actual use of the system. The investigation of Geffen and Straub (1997) stated that perceived attributes of the system can differ between genders. The perception of the Perceived Usefulness of the system was reported as being different between genders but the actual use of the system was reported as not being affected by gender and personal innovativeness by Agarwal and Prasad (1998).

The study of Wang et al., (2005) investigated 310 pre-service teachers attitude toward use of the internet. They found that the use of the internet had been influenced by teachers' Confidence Level, Attitude toward the internet and Perceived Usefulness as well as Friends Support.

Teo et al., (2008) undertook an empirical study of TAM in order to validate it and to explain the intention to use technology among educational users. Their study investigated 239 pre-service teachers who self-reported their intention to use technology. Their results provided evidence of the effectiveness of the TAM model in predicting the intention to use technology with educational users.

There are differences between the classroom environment and the business or commercial environment and Teo et al.'s research attempted to investigate these differences. This research was replicated in 2009 with 495 pre-service teachers with two culturally different samples addressing the critique of TAM by some researchers (Lee, Kozar, & Larsen, 2003) stating that TAM is investigated mostly on one sample and therefore the cultural issue had not been addressed (Teo, Lee, Ching, & Wong, 2009).

Some other studies addressed the learner's perspective of TAM. Brahmasrene and Lee (2012) in their study investigated the intent of learners to continue with online learning programs. They identified three constructs that defined the learner's intent to continue: perceived social ability, online learning readiness and perceived usefulness. There are many studies that find a relationship between learning satisfaction in online learning and social interaction (Rovai & Barnum, 2003; Yang, Tsai, Kim, Cho, & Laffey, 2006). If the learner fails to achieve feeling of a community and feels isolated, this would result negatively on online classes and learner satisfaction (Vonderwell, 2003). Shroff, Deneed and Ng (2011) investigated students' attitude towards e-portfolio acceptance. The result stated that perceived ease of use had a significant influence on attitude and strong influence on perceived usefulness. No study has yet investigated the influence of the educational environment and all its constructs on technology acceptance attitude. This thesis aims to close this gap. The WIHIC instrument is added to TAM to design the ETAM instrument, designed specifically to investigate technology acceptance in the educational environment.

## 2.5. CHAPTER SUMMARY

In summary, this chapter has presented the theoretical background of the Technology Acceptance Model (TAM), based on Davis's original work. It has also presented three additional TAM models, namely, the technology acceptance model (TAM2), the Unified Theory of Acceptance and Use of the Technology (UTAUT) and the more recent technology acceptance model (TAM3). The main shortcomings

from the original model were addressed in the development of these new models. An overview of literature has indicated that the use of TAM has been mainly limited to the business environment. In most of the studies presented, students were used to simulate professional use, but the use of educational software by students and impact of the educational environment on their use was not studied. Where educational software was studied, the focus was on online and e-learning, new technologies (mobile), and new media. Most researchers used either the original TAM model or the UTAUT model in their investigations with the addition of many new constructs: Social Ability, Readiness, Enjoyment, Computer Efficacy, Self-Efficacy, Trust, Confidence, Facilitating Conditions, etc. It is evident that there is a lack of systematic investigations into the effect of environmental factors on the technology acceptance by students or teachers in the classroom. This thesis uses the Technology Acceptance Model (TAM) to investigate the technology acceptance in an educational setting. The objective was to increase the knowledge and understanding of the factors that influence technology acceptance in the educational environment. The TAM instrument was one of two key elements for this new technology acceptance model. The second element was the *What Is Happening In this Classroom* (WIHIC), the educational instrument used to investigate the educational environment influence on technology acceptance and complement the TAM in this new model. The WIHIC has been used and validated in many studies (and accepted as the most comprehensive instrument) to investigate the impact of the classroom environment on learning and teaching.

The following chapter will explain the constructs of this educational environment instrument, its development and uses.

## Chapter 3.

### **ENVIRONMENTAL INFLUENCES**

While not explicitly recognised by efficacy theorists, some of these sources can be attributed to the psychosocial learning environment that students experience in their schools and classrooms. For example, students in classrooms regularly observe their peers performing tasks successfully and unsuccessfully. Even a cursory review of the learning environment literature of the past three decades indicates that the learning environment is not an inert contributor to the sources of academic efficacy identified by Bandura and Schunk. Indeed it is striking that academic efficacy theory has not recognised the potential of psychosocial environment in explaining academic efficacy. (Dorman, Fisher, & Waldrip, 2006, p. 7)

#### **3.1 INTRODUCTION**

Environmental factors are considered, according to Fishbein and Ajzen (2010), as one of three necessary and sufficient factors to produce behaviour. They identified the following three common determinants of behaviour: intention, environmental constraints and skills.

Fishbein's theory of reasoned action suggests:

that intention is the best single predictor of behaviour but it is also important to take skills and abilities as well as environmental factors (i.e., behavioural control) into account... therefore, people are said to perform a behaviour because they intend to do so, they have the requisite skills and abilities, and there are no environmental constraints to prevent them from carrying out their intentions (i.e., they have favourable intentions and actual behavioural control). (Fishbein & Ajzen, 2010, p. 21)

In addition to these three necessary factors (intention, environmental constraints and skills,) as defined by Fishbein and Ajzen, the following determinants of

intention were defined as: the person believes that the advantages of performing the behaviour are greater than the disadvantages, the person perceives more social pressure to do it than not to; the person perceives that performing the behaviour is more consistent with their self-image than not; the emotional reaction to performing the behaviour is more positive than negative; and the person perceives that they have the capabilities to perform or that their perceived self-efficacy is positive rather than negative. The importance of the impact of the environment on attitude toward the behaviour as one of three necessary factors is clearly emphasised. The special case of the environment is a classroom learning environment and the research into learning environment started with Lewin (1936) and Moos (1974). Fisher and Fraser have undertaken research into learning environments for the last three decades and opened a new research field of investigation called learning environment research. Fraser (1998) identified the following areas regarding the investigation of the classroom environment: investigating and establishing associations between student outcomes and perceptions of the classroom environment; establishing and investigating differences between the teachers' perception of the classroom environment and the students' perceptions; investigating student performances in their preferred environment and the difference in students' perceptions of preferred and actual environments; the effects of student characteristics on classroom environments; and the influence of characteristics of classroom environments on curriculum development. Fraser noted that

The field of classroom environment provides an opportunity for school psychologists and teachers to become sensitised to subtle but important aspects of classroom life, and to use discrepancies between students' perceptions of actual and preferred environment as a basis to guide improvements in classroom. (1998, p. 25)

This study involves an investigation of the impact of the classroom environment on students' attitudes toward technology acceptance. The technology acceptance model (TAM) is used in this project in educational settings. The aim of this investigation is to increase understanding of the factors that influence technology

acceptance in the classroom environment. There are differences between the classroom environment and business or commercial environments. This research attempts to investigate the impact of the classroom environment on students' attitudes toward technology acceptance. The instrument used to assess the classroom environment influence on technology acceptance was the What Is Happening In this Class (WIHIC). This instrument identifies the specific constructs of the classroom environment and is described in the following sections.

Section 3.2 outlines the historical background of learning environment research. In section 3.3, the development of the instrument is presented. A description of the What Is Happening In this Class (WIHIC) instrument is presented in the section 3.4. In section 3.5, a review of research studies that used the WIHIC is outlined. Section 3.6 reviews the studies that investigated technology-rich classroom learning environments. Section 3.7 discusses the relevance of the WIHIC instrument to this study and the last section, 3.8, summarises the chapter.

## **3.2 HISTORICAL BACKGROUND OF LEARNING ENVIRONMENT RESEARCH**

Educators often rely exclusively on assessing achievement and pay scant attention to the quality of the learning environment. Teachers should not feel that it is a waste of valuable teaching time to put energy into improving their classroom climates because the research convincingly shows that attention to classroom environment is likely to pay off in terms of improving student outcomes. (Fisher, Aldridge, Fraser, & Wood, 2001, p. 1)

The concept of learning environment started with Lewin (1936) and Murray (1938). Lewin recognized the importance of environmental influences on human behaviour. He defined human behaviour as the interaction of environment and individual characteristics. He introduced the formula to describe human behaviour as:

$$B = f(P, E)$$

Where:

B-human behaviour

P-the personal characteristics

E -the environmental characteristics (Lewin, 1936).

Observational techniques and perceptions of viewers have been used to investigate associations between the environment and individuals. Murray (1938) developed a Needs-Press model to clarify the relationship between an individual's needs (including goals and drives) and environmental demands (including stimulus, treatment, and process variables). He defined perception of the environment by participants as *beta press* and the view of an outside observer as *alpha press*. This model has been extended by Stern, Stein and Bloom (1956).

Getzels and Thelen (1960) proposed a model that aimed to predict behaviour and student outcomes based on the interaction of personality, expectation and the environment. This was followed by Stern (1970) and his theory of person-environment congruence which implied that the combination of person need and environment would improve student outcomes. The approach used involves consensual beta press (Stern, Stein, & Bloom, 1956) which distinguished between personal forms termed 'private' beta press (the individual view of the environment) and 'consensual' beta press (shared view of the environment). Doyle (1979) has suggested that classrooms should be regarded as ecological settings by putting strong emphasis on the inter-relationships between all involved parties in classroom settings. This research led to the development of many personality theories but environmental measures were not considered at that time. The research into environmental measures, later, led to the development of many instruments for the investigation of environmental influences on students' outcome.

Walberg and Anderson (1968) continued the investigation of learning environments with the use of *Learning Environment Inventory* (LEI). The LEI was used in order to investigate and assess students' perceptions of learning environments within the

evaluation of the Harvard Project Physics (Walberg & Anderson, 1968). Furthermore Walberg is well known for his model of educational productivity which was defined by nine factors: student ability, age, motivation, quality and quantity of instructions, psychological climate at home, classroom social group, the peer group outside the classroom, and mass media, especially television viewing (Henderson, Fisher, & Fraser, 1998). Generally in these early studies it was shown that the classroom environment was a particularly important influence on student outcomes.

Moos' (1974) findings from his work on diverse environments (hospital wards, prisons, school classrooms military companies, university residences and work milieu) led the way to the development of the *Classroom Environment Scale* CES (Moos & Trickett, 1987). The CES was developed to investigate students' perceptions of the whole-class learning environment.

These two questionnaires (LEI and CES) were the bases for the early development of the field of learning environment studies, and were used in a variety of human environments investigations, and they provided models for the development of many instruments over last three decades. Most of these questionnaires are designed in two forms: an actual form which asks questions about the learning environment participants are in, at the current time, and preferred form, which asks questions about the learning environment the participants would prefer to have (Fraser, Fisher, & McRobbie, 1996).

In his work, Moos (1974) conceptualised human environment characteristics and categorised them into three dimensions; relationship, personal development and maintenance and change of the system. The *relationship dimension* includes the nature and intensity of personal relationships, supported by individuals and the level of involvement. The *personal dimension* includes individual progress towards self-enhancement, knowledge development progress, grades and awards. The *system maintenance and system change dimension* includes the extent of environmental regulation, controlled classroom rules, objective and goals of study (Moos & Trickett, Classroom environment scale manual, 1987) and is defined as

“the extent to which the environment is orderly, clear in expectation, maintains control, and is responsive to change” (Waldrip & Fisher, 1997, p. 4).

Major developments in the investigation of the classroom environment began with Fraser in early 1980s. He conceptualised learning environment as having a social, psychological and pedagogical context, and the place where learning that happens affects the students’ achievement. Fraser (2002) noted that learning environment research has “undergone remarkable growth, diversification and internalisation during the past 30 years” and that a number of “economical, valid and widely applicable questionnaires have been developed and used for assessing students’ perceptions of classroom environment “ (2002, p. 1).

Fraser, Fisher and McRobbie had questioned the assumption that all students would have the same or common experience of their classroom. They based their idea on interpretive studies, interviews and classrooms observations

interviews involving teachers and students suggested that there were groups of students (termed "target" students) who were involved more extensively in classroom discussions than the other students. These target students were found to have more favourable perceptions of the learning environment than those students less involved, suggesting that there could be discrete and differently-perceived learning environments within the one classroom. (Fraser, Fisher, & McRobbie, 1996, p. 2)

These findings raised the questions: How do we cater for individual perceptions when using an instrument designed for the class perception and how do we investigate the differences between groups (for example gender) with the same instrument? These questions motivated Fraser et al. (1996) to design a different form of the learning environment questionnaire which focused on the questions about individual’s perception of their role in the classroom environment. This form is called a Personal Form. The other form asks questions about students’ perception of the learning environment as a whole and is called the Class Form. Differences between Personal and Class forms are presented in Table 3.1.

Table 3.1.

*Differences between Personal and Class Form Wording of Items*

Scale	Class Form	Personal Form
Student Cohesiveness	Students are able to depend on each other for help during laboratory classes. (+)	I am able to depend on other students for help during laboratory classes. (+)
Open-endedness	In our laboratory sessions, different students do different experiments. (+)	In my laboratory sessions, I do different experiments than some of the other students. (+)
Integration	The laboratory work is unrelated to the topics that we are studying in our science class. (-)	The laboratory work is unrelated to the topics that I am studying in my science class. (-)
Rule Clarity	Our laboratory class has clear rules to guide student activities. (+)	My Laboratory class has clear rules to guide my activities. (+)
Material Environment	The laboratory is crowded when we are doing experiments. (-)	I find that the laboratory is crowded when I am doing experiments. (-)

Adapted from Fraser et al. (1996, p. 4)

The work of Lewin and Murray together with the contributions of Moos and Walberg, provided the ground work for the future development of a new field of learning environment research. This research has grown in the last 30 years with many studies contributing to the acceptance and recognition of this important field of study. The *Journal of Learning Environments Research: An International Journal* (Fraser B. J., 1998) has been introduced as well as the books on learning environments such as *Technology-rich learning environments: A future perspective* (Khine & Fisher, 2003), *Contemporary Approaches to Research on Learning Environments: Worldviews* (Fisher & Khine, 2006), *Handbook of Research on Science Education* (Fraser B. J., 2007) and the *Second International Handbook of Science Education* (2011).

As discussed previously, the extensive and deep investigation into learning environments has led to the development of many instruments tailored to investigate specific subjects, or groups of students, in different classroom environments. The historical development of a sample of these instruments, designed for investigations in the field of learning environments, is presented in the following section. Each of the selected instruments is valuable in its own right and has been used in many studies.

### **3.3 DEVELOPMENT OF LEARNING ENVIRONMENT INSTRUMENTS**

Walberg developed the *Learning Environment Inventory* (LEI) for use when evaluating the Harvard Project Physics curriculums, in order to investigate and assess students' perceptions of their learning environment (Walberg & Anderson, 1968). The LEI had 5-point Likert scale response for each item.

The *My Class Inventory* (MCI) was developed as a simplified form of the LEI by Fisher and Fraser (1981). It was developed specifically for use with young children. Accordingly, all the items of the instrument were written at a lower reading level. Children were then asked to circle either 'yes' or 'no' answer which represented agreement or disagreement with each item. It has been validated by Fisher and Fraser (1981) and Fraser and O'Brien (1985) with 758 students from 32 classrooms in eight schools in Sydney, Australia. It has also been validated in Singapore with primary students and found to be a valid and very useful instrument (Goh & Fraser, 1998, 2000). The same instrument also is useful for students with reading difficulties.

A revised version of the MCI with 18 items has been used in Washington state with 2800 grade 4-6 students from 20 schools (Sink & Spencer, 2005). The objective was to evaluate the schools' counselling programmes and the MCI was used as an assessment tool in the process. Mink and Fraser (2005) have undertaken another MCI study with 120 grade 5 students, in order to evaluate an educational innovation, using the learning environment as a criterion of success. They found

that students improved their attitude towards mathematics with the teachers who participated in the program. Another study conducted in Texas (Scott, Fraser, & Ledbetter, 2008) used the MCI with 588 students in order to evaluate the effectiveness of instruction using a textbook, science kits and a combination of the two. The results added to the reliability and validity of the MCI and suggested that using a science kit was associated with a more positive learning environment.

The instrument was further developed by Goh, Young and Fraser (1995) by changing YES-No response format to a Seldom, Sometimes, and Most of the Time and by adding a Task Orientation Scale.

Fraser (1990) developed the *Individualised Classroom Environment Questionnaire (ICEQ)* instrument specifically for classrooms operating with an individualised curriculum. The validation of the ICEQ was undertaken by Rentoul and Fraser (1980) in a study in Sydney with 255 junior high students in 15 schools. The results suggested that the ICEQ is a valid questionnaire and that student enjoyment was higher in classrooms which were perceived by the students as having higher participation and personalization. The ICEQ also was used by Fraser and Butts (1982) in high schools in Sydney with 812 participants, and in two studies in Tasmania: Nash and Fisher (1983) with 116 science students and Fraser and Fisher (1982). The instrument had also been validated abroad in Indonesia by Fraser, Pearse and Azmi (1982) with 373 students in 18 science classes. The results suggested that satisfaction was higher in classes with less independence and higher involvement, and that anxiety was reduced where students perceived greater differentiation and involvement. The ICEQ has been used in Brunei by Asghar and Fraser (1995) to investigate associations between students' attitude and their learning environment perceptions. The results indicated that classroom environment dimensions were predictors of students' attitudinal outcomes.

A new short version of the ICEQ was developed as the *Science Classroom Environment Survey (SCES)* to investigate the use and effectiveness of laptop computers in the classroom. The instrument was given to 863 science students in 44 classrooms in 14 schools in Australia. The laptop had been used in only one

school where 433 students participated and 430 students participated from other schools where laptops had not been used (Stolarchuk & Fisher, 2001). The result confirmed the reliability and validity of the instrument and also found that laptop have little effect on students' perception of their learning environment.

The *Questionnaire on Teacher Interaction (QTI)* (Wubbels & Levy, 1993) originated in the Netherlands. It was developed and used to investigate relationships between teachers and students in studies in their country (Wubbels & Brekelmans, 1998). The instrument was developed to investigate the student perception of the following behavioural aspects: Leadership, Helpful/Friendly, Understanding, Student Responsibility/Freedom, Uncertain, Dissatisfied, Admonishing and Strict. Each of these eight constructs had a five point response scale defined from Never to Always. Wubbels and Levy (1993) had cross-validated the instrument on different levels in the USA. The QTI has been used in many studies. Fisher, Henderson and Fraser (1995) carried out a study in Australia, (Goh & Fraser, 1998; 2000; 1996) in Singapore and Fisher, Quek and Fraser (2001) carried out a study in both Singapore and Australia (Fisher, Goh, Wong, & Rickards, 1997). Scott and Fisher (2001) also validated the QTI and translated it into standard Malay language in Brunei. They investigated associations between student-teacher interpersonal behaviour and achievement with 3104 primary students in 136 classrooms. Their findings confirmed the reliability and validity of the instrument for that environment.

An English version of the QTI has been validated by Khine and Fisher (2002) and Riah and Fraser (1998). Kim, Fisher and Fraser (2000) and Lee and Fraser (2001) validated a Korean version of the QTI. Soerjaningsih, Fraser and Aldridge (2001) translated the QTI into the Indonesian language and validated it in Indonesia. Kim, Fisher and Fraser used the QTI with the WIHIC to investigate associations between student attitudes to science and their classroom environment perception. Their findings suggested that the boys have a more positive perception of their teacher's interpersonal behaviour, their classroom environment, and their attitude toward science classes than did girls. Fraser, Aldridge, and Soerjaningsih (2010) undertook an investigation with 422 university students in Indonesia to investigate

associations between students' perceptions of instructor-student interaction and their achievement and attitude. In their study Wei, den Brok and Zhou (2009) investigated association between student and teacher interpersonal behaviour. Their results suggested that the Chinese translation of the QTI was valid and reliable in that study.

Another instrument used specifically in the laboratory classroom environment and named *Science Laboratory Environment Inventory (SLEI)* was developed by Fraser, Giddings and McRobbie (1995). This instrument has five-item scales (Student Cohesiveness, Open-Endedness, Integration, Rule Clarity and Material Environment) with the five response alternatives (Almost Never, Seldom, Sometimes, Often, and Very Often). The instrument had been validated in USA, Canada, England, Israel, Nigeria and Australia (Fisher, Henderson, & Fraser, 1997; Fraser & McRobbie, Science laboratory classroom environment at schools and universities: A cross-national study, 1995). In one cross-national study class and personal forms of the SLEI instrument were administered to 5447 students in 269 senior high schools and universities in these six countries. The result suggested that the instrument was valid for both the individual and class unit of analysis. The SLEI has been proven valid in all countries involved in the study (Fraser, Giddings, & McRobbie, 1992). Fraser and Lee (2009) investigated the perception of students in science and humanities classrooms in Korea. Results suggested that students from a science-independent stream had a more positive perception of their laboratory environment than did other streams (humanities and science-oriented). Henderson, Fisher and Fraser (2000) investigated associations between students' perception of teacher interpersonal behaviour and laboratory learning environment and student achievement in laboratory settings. The results confirmed previous studies in that perceptions of the learning environment were stronger for the students' attitudinal outcomes than for their achievement or practicum outcome. Gupta, Khouli and Sharma (2010) investigated students' perceptions of their science laboratory learning environment in an Indian classroom. They used a modified SLEI and the Test of Science Related Attitudes (TOSRA) (Fraser, 1981). The instruments

were administered to 460 students (grades 10 to 12) in 9 science classes. This study confirmed the international validity and reliability of the SLEI.

Kongkarnka and Fisher (2008) developed the *Tertiary Chemistry Learning Environment Questionnaire (TCLEQ)* to investigate students' perceptions and attitude toward chemistry learning. The questionnaire contained 49 items in seven scales, namely, Student Cohesiveness, Cooperation, Equity, Integration, Investigation, Teacher Support and Material Environment. In addition, they used the *Test of Chemistry-Related Attitude (TOCRA)* instrument with two scales, Adoption of Scientific Attitudes, and Enjoyment of Science Lessons. The findings of the study indicated that positive associations exist between learning environment constructs and attitude toward chemistry learning.

Taylor, Fraser and Fisher (1997) developed the *Constructivist Learning Environment Survey (CLES)* in order to assist teachers to reflect and review their teaching practice. Fraser stated that according to the constructivist view "meaningful learning is a cognitive process in which individuals make sense of the world in relation to the knowledge which they already have constructed, and this sense-making process involves active negotiation and consensus building" (Fraser, 2002, p. 5). The CLES had five scales (Personal Relevance, Uncertainty, Critical Voice, Shared Control and Student Negotiation) with five responses from Almost Never to Almost Always. Wilks (2000) used a modified CLES in Singapore with two additional scales (Political Awareness and Ethics of Care).

The CLES was translated into the Korean language and used in investigations in Korea by Kim, Fisher, and Fraser (1999). It has also been translated into Chinese by Aldridge, Fraser, Taylor and Chen (2000). In this cross-national study they administered the questionnaire to students in Australia (1081 students in 50 classes) and Taiwan (1879 students in 50 classes). Their results suggested that both versions (English and Mandarin) of the instrument were valid and reliable. The CLES was administered to kindergarten students in a study undertaken by Peiro and Fraser (2009). This study validated a modified version of the English instrument and a Spanish version of the CLES instrument.

A modification of the CLES was developed to cater for online teaching and learning. This instrument was designed by Taylor and Maor (2000) and named the *Constructivist On-Line Learning Environment Survey (COLLES)*. An objective of this electronic survey was to compare students' preferred online learning environment with their actual experience. The COLLES is accessible as an open source through Moodle -Modula Object-Oriented Dynamic Learning Environment (Dougimas & Taylor, 2002).

Nix, Fraser and Ledbetter (2005) developed a new version of the CLES named the *CLES-Comparative Student version*. They used this instrument with 1079 students in 59 classes in Texas, in order to investigate the classroom impact of teachers' participation in a professional development program with constructivist principles. The study confirmed the validity and reliability of the COLLES.

Fraser and Treagust (1986) developed the *College and University Classroom Environment Inventory (CUCEI)* for higher education use. Fraser, Williamson and Tobin used the CUCEI in a high school in Australia. The research was undertaken with 536 adult learner students from 45 classes. The results suggested that adult returning students perceived their classes as higher in satisfaction, involvement, individualisation and innovation. Yarrow, Millwater and Fraser (1997) used the CUCEI in a study with pre-service teacher and investigated their perceptions of learning environment.

Waldrip and Fisher (1996) developed the *Cultural Learning Environment Questionnaire (CLEQ)* in order to investigate students' perception of their learning environment and association with their cultural background and their attitude towards their class. The instrument has eight scales with five items in each scale giving a total of 40 items. Students' responses were measured on four point Likert scale from Almost Always to Almost Never. Koul and Fisher (2008) used the CLEQ to investigate student cultural background and its association with the learning environment perceptions of 560 students (years 7 and 8) from Australian public schools. This study provided validation data for the CLEQ and also identified the trends in Western Australian schools in regards with cultural sensitivity. Koul and

Fisher (2008) investigated students' perceptions of their learning environment and the associations between cultural background and students' attitude towards the class. The CLEQ instrument had been administered to 560 students (years 7 and 8) from a multicultural school in Western Australia. The result suggested that gender differences were significantly different in only two scales. The female students perceived more positively the equity and communication shown by the teacher. The result has found little evidence to support the difference in perception of learning environment based on cultural background (Koul & Fisher, 2008).

Fraser and Dhindsa (2010) used the CLEQ in their study to investigate culturally-sensitive factors. The instrument was administered to 912 students in Brunei. The results suggested that both female and male students perceived that they were being treated equally. It also suggested that moderately authoritative teachers encouraged collaboration and competitiveness in the science classroom.

Special development of these questionnaires has occurred in technology-rich classroom environments. There are specific tools developed to cater for the needs of this type of classroom environment. Some examples are the *Computer Laboratory Environment Inventory (CLEI)*, the *Distance and Open Learning Environment Scale (DOLES)* was developed by Jegede, Fraser and Fisher (1998) to investigate distance learning courses learning environment influences, and the *Web-based Learning Environment Instrument (WEBLEI)* was developed by Chang and Fisher (2003) to investigate on-line courses in higher education.

Zandvliet and Baker (2003) investigated the evaluation of the physical and psychosocial learning environment in Internet classrooms in British Columbia, Canada. They used a combination of the WIHIC and the *Computerised Classroom Environment Checklist (CCEC)*. They found that students' satisfaction of learning were associated with student autonomy/independence and task orientation. Further they found that workspace and visual environments were significantly associated with the physical and psychosocial learning environments in technology-rich classroom (Zandvliet & Buker, 2003)

The *Technology-Rich Learning Outcome-Focused Learning Environment Inventory (TROFLEI)* was developed by Aldridge, Dorman and Fraser (2004) to investigate and evaluate an outcome-based course. The TROFLEI contains all the WIHIC scales (Students Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity) and three additional scales (Differentiation, Computer Usage and Young Adult Ethos). The instrument has been used in Western Australia and Tasmania with 1249 high school students who had been given both actual and preferred forms of TROFLEI instrument. The results strongly supported the validity and reliability of the new instrument. This instrument has been used in schools with outcome-based learning environments (Aldridge & Fraser, 2008).

Zandvliet (2007) developed the *Place-Based and Constructivist Environment Survey (PLACES)* with scales adapted from four different environment instruments: the Environmental Science Learning Environment Inventory (ESLEI) (Henderson & Reid, 2000), the What Is Happening In this Class (WIHIC), the Science Learning Environment Inventory (SLEI) and the Science Outdoor Learning Environment Instrument (SOLEI) (Orion, Hofstein, Pinchas, & Giddings, 1994). A total of seven scales from these four instruments were used. The Student Cohesion, Integration and Involvement scales were taken from ESLEI. The Teacher Support and Cooperation Scales were taken from the WIHIC. The Open-Endedness scale was taken from the SLEI and the scale of Environmental Interaction was taken from the SOLEI. The students' responses were taken with four point Likert scale ranging from Almost Always to Almost Never.

In summary, an overview of 16 learning environment questionnaire scales is presented in Table 3.2.

Table 3.2

*Overview of Scales Contained in the 16 Classroom Environment Instruments*

Instrument	Author	Items per scale	Scales classified according to Moos's scheme		
			Relationship dimensions	Personal development	System maintenance and change dimensions
Learning Environment Scale (LEI)	(Walberg & Anderson, 1968)	7	Cohesiveness Friction Favouritism Cliqueness Satisfaction Apathy	Speed Difficulty Competitiveness	Diversity Formality Material Environment Goal direction Disorganisation Democracy
Classroom Environment Scale (CES)	(Moos, 1974)	10	Involvement Affiliation Teacher support	Task orientation Competition	
Individualised Classroom Environment Questionnaire (ICEQ)	(Rentoul & Fraser, 1979)	10	Personalisation Participation	Independence Investigation	Differentiation
My Class Inventory (MCI)	(Fisher & Fraser, 1981)	6-9	Cohesiveness Friction Satisfaction	Difficulty Competitiveness	
College and University Classroom Environment Inventory (CUCEI)	(Fraser & Treagust, 1986)	7	Personalisation Involvement Student cohesiveness Satisfaction	Task orientation	Innovation Individualism
Questionnaire On Teacher Interaction (QTI)	(Fisher, Henderson, & Fraser, 1995)	8-10	Helpful/friendly Understanding Dissatisfied Admonishing		Leadership Student responsibility And freedom Uncertain Strict
Science Laboratory Environment Survey (SLEI)	(Fraser, Giddings, & McRobbie, 1995)	7	Student cohesiveness	Open-endedness Integration	Rule clarity Material environment
Constructivist Learning Environment Survey (CLES)	(Taylor, Dawson, & Fraser, 1995)	7	Personal relevance Uncertainty	Critical voice Shared control	Student negotiation
What Is Happening In this Classroom (WIHIC)	(Fraser, Fisher, & McRobbie, 1996)	8	Students cohesiveness Teacher support Involvement	Investigation Task orientation Cooperation	Equity
Cultural Learning	(Waldrip & Fisher, 1996)	8	Teacher Authority Congruence	Collaboration Competition	Equity

Instrument	Author	Items per scale	Scales classified according to Moos's scheme		
Environment Questionnaire (CLEQ)	(Newby & Fisher, 1997)	5	Communication	Open-endedness	Rule clarity
Computer Laboratory Environment Inventory (CLEI)			Defence Modelling		
Distance and Open Learning Environment Scale (DOLES)	(Jegede, Fraser, & Fisher, 1998)	5	Students cohesiveness	Task orientation	Flexibility
Web-Based Learning Environment Instrument (WEBLEI)			Teacher support		
Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)	(Chang & Fisher, 2003)	4	Personal Involvement	Interaction	Home environment
Place-based And Constructivist Learning Environment (PLACES)			Access Response		
Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI)	(Aldridge, Dorman, & Fraser, 2004)	10	Student cohesiveness	Task orientation	Equity
Constructivist-Oriented Environment Survey (COLES)			Teacher support		
Place-based And Constructivist Learning Environment (PLACES)	(Zandvliet, 2007)	5	Involvement	Cooperation	Differentiation
Constructivist-Oriented Environment Survey (COLES)			Young adult ethos		
Constructivist-Oriented Environment Survey (COLES)	(Aldridge, Fraser, Bell, & Dorman, 2012)	11	Cohesiveness	Differentiation	Equity
Constructivist-Oriented Environment Survey (COLES)			Student Involvement		
Constructivist-Oriented Environment Survey (COLES)	(Aldridge, Fraser, Bell, & Dorman, 2012)	11	Personal relevance	Cooperation	Clarity of assessment criteria
Constructivist-Oriented Environment Survey (COLES)			Student cohesiveness		
Constructivist-Oriented Environment Survey (COLES)	(Aldridge, Fraser, Bell, & Dorman, 2012)	11	Teacher support	Cooperation	Clarity of assessment criteria
Constructivist-Oriented Environment Survey (COLES)			Teacher support		

Adapted from Fraser (1998)

Many instruments used in the research of classroom environment were more relevant to the teacher –centred classroom rather than today's student-centred classrooms. In order to address this issue the WIHIC instrument was developed with the range of the dimensions that reflect the needs of today's classrooms (Aldridge & Fraser, 1997). The following section describes the WIHIC instrument that was selected for use in this research.

### 3.4 WHAT IS HAPPENING IN THIS CLASS (WIHIC) INSTRUMENT

This section describes the development of the What Is Happening In this Class (WIHIC) instrument which came about from a need to have an instrument which successfully incorporated scales from previous instruments, that had proven to be significant predictors of students' outcomes and with additional scales that accommodate contemporary educational concerns (e.g. equity and cooperation) (Fraser, 2002). Because of this it maps a wider area of learning environments than any instrument before.

The WIHIC was developed by Fraser, Fisher and McRobbie (1996) to measure high school students' perceptions of their classroom environment. The instrument has proven to be able to measure students' perceptions of their learning environment and to have predictive validity on cognitive and affective student outcomes (Fraser, 2002). There are two forms of the WIHIC namely, Class and Personal. The personal form allows researchers to investigate individual views of the environment, called *private beta press*. The WIHIC *personal form* was used in an investigation of individual students' perception of their role within the classroom and particularly in identifying the subgroups based on sex or culture (Fraser & Tobin, 1991). The personal form is better suited for use in investigations of perceptions within subgroups (gender or ethnic groups) or investigation of case studies of individual students (Sinclair & Fraser, 2002). The class form allows researchers to investigate group views of the learning environment named *consensual beta press*. The *class form* is used to investigate students' perception of her/his perception of the class as whole (Fraser, Fisher, & McRobbie, 1996; Fraser, Giddings, & McRobbie, 1995; Fraser & McRobbie, 1995). Each form, class and personal, has two versions: the actual and preferred version.

The first version of the WIHIC instrument had nine scales and ten items for each scale. The scales were: Student Cohesiveness, Teacher Support, Involvement, Autonomy/Independence, Investigation, Task Orientation, Cooperation, Equity and Understanding. It has been refined by Fraser, Fisher and McRobbie with statistical analysis of data from 355 high school science students (grade 9 and 10) in 17 classes

of five Australian schools and interviewing of students about their views of their classroom environment. This process resulted in a final version of 56 items in seven scales. The final form of the WIHIC (Aldridge & Fraser, 2000) contains seven eight – item scales (Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity).

The WIHIC scales measure the perception of learning environment for all three dimensions identified and proposed by Moos (1974): *personal development, relationship, and system maintenance and system change*. The *personal development dimension* is measured in WIHIC by using the Investigation, Task Orientation, and Cooperation scales. The relationship dimension is measured in the WIHIC by using the scales of Teacher Support, Student Cohesiveness and Involvement whilst the *system maintenance and system change* is measured in the WIHIC by using the dimension Equity. The WIHIC questionnaire uses a five-point Likert –type scale. The responses are: Almost Never, Seldom, Sometimes, Often, and Almost Always (Dorman, Cross-validation of the What Is Happening In this Class? (WIHIC) questionnaire using confirmatory factor analysis, 2003). A description of the WIHIC scales is presented in Table 3.3.

Table 3.3.

*Scale Descriptions for the What Is Happening In this Class (WIHIC) Instrument*

WIHIC Scale	Description: The extent to which...	Moos Dimension
Student Cohesiveness	...students are friendly, know and are supportive of each other.	Relationship
Teacher Support	... the teacher helps, befriends, and is interested in students development and success.	Relationship
Involvement	... students have attentive interest, participate in class discussion and work, and are involved with other students in assessing the viability of new ideas and enjoy in class activities.	Relationship
Investigation	... there is emphasis on the skills and of procedure of inquiry and their use in problem-solving and investigation.	Personal development
Task Orientation	... it is important to complete planned activities and stay focused on the subject	Personal development

	matter.	
Cooperation	... students cooperate, rather than compete, with each other during activities.	Personal development
Equity	... the teacher treats students equally, including distributing praise, question distribution and opportunities to be included in discussions.	System maintenance and system change

Adapted from den Brok et al., (2005, p. 36)

Typical items of the WIHIC instrument are: the student Cohesiveness scale, “I make friends among students in this class”, the Teacher Support scale “The teacher takes a personal interest in me”, the Investigation scale “I am asked to think about the evidence for my statements”, the Involvement scale “I discuss ideas in this class”, the Task Orientation scale “I know the goals for this class”, the Cooperation scale “I work with other students on projects in this class”, and Equity scale “I am treated the same as other students in this class”. (Fraser, Fisher, & McRobbie, 1996)

The WIHIC instrument has been validated across number of the countries and subjects (Aldridge, Laugksch, & Fraser, 2004). The original questionnaire has been used in Taiwan (Aldridge & Fraser, 2000, 1997), Singapore (Chionh & Fraser, 1998; Fraser & Chionh, 2000), Korea (Kim, Fisher, & Fraser, 2000), Indonesia (Adolphe, Fraser, & Aldridge, 2003), India (Koul & Fisher, 2006) Brunei (Khine & Fisher, 2001; Riah & Fraser, 1998), Canada (Dorman, 2003; Raflaub & Fraser, 2002; Zandvliet & Fraser, 2004), USA (Allen & Fraser, 2007, 2002; James & Fraser, 2004; MacDowell-Goggin & Fraser, 2004; Moos & Fraser, 2001), New Zealand (Saunders & Fisher, 2006). This cross-cultural validity gives WIHIC additional strength above country-specific instruments (den Brook, Fisher, Rickards, & Bull, 2005). This is today the most widely used instrument in the investigation of learning environments research.

### 3.5 USE OF THE WIHIC IN LEARNING ENVIRONMENT RESEARCH

In his review Fraser reported that:

Classroom environment dimensions have been used as criterion variables in research aimed at identifying how the classroom environment varies with

such factors as teacher personality, class size, grade level, subject matter, the nature of the school-level environment and type of school. (Fraser, 2002, p. 13)

Aldridge and Fraser (1997) used the WIHIC with 50 secondary school classes in Australia and Taiwan. They investigated students' perception of Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity. The findings suggested that students' perceptions of their learning environment were impacted by socio-cultural factors. The WIHIC instrument has been used in the investigation of associations between learning environments and student attitude toward the subject in mathematics classrooms in Australia (Rawnsley & Fisher, 1998). It was found that students have more positive attitude towards mathematics in classes where the teacher is perceived as more supportive and equitable, and students were engaged in investigations. Chionh and Fraser (1998) used actual and preferred forms of the WIHIC to investigate the associations between actual classroom environment and outcomes. The study showed that better examination scores were found in geography and mathematics classes where student perceptions of the environment was seen as being more cohesive.

A Chinese language version of the WIHIC was developed by Chua, Wong and Chen (2001) based on Aldridge, Fraser and Huang (1999a) version of the WIHIC. This was a bilingual instrument with all items presented in both English and Chinese languages. The WIHIC also has been translated into the Indonesian language and used in computing classes with university students. The study established the validity and usefulness of the WIHIC with a sample of 2498 students in 50 classes (Margianti, Fraser, & Aldridge, 2001a, 2001b).

WIHIC studies in Singapore have established the relationship between student outcomes and classroom environment perception. Goh established associations between the classroom environment and mathematics achievement and attitudes (Goh & Fraser, 1998, 2000). Fraser and Chionh (2000) demonstrated associations between WIHIC scales and student outcomes, Khoo and Fraser (1998) reported

associations between student satisfaction and WIHIC dimensions, and Teh and Fraser (1995) showed associations between classroom environment, achievement and attitude. In their study Soto-Rodriguez and Fraser (2004) used a Spanish translation of the WIHIC administered to 1105 students (grade 2-5). Their findings identified that students with limited English language proficiency perceived their learning environment less positively. Allen and Fraser (2002) administered the Spanish translation of the WIHIC to 520 students and 120 parents in South Florida. In their findings, parents reported a less positive perception of the actual learning environment than students. Both parents and students preferred a more favourable learning environment than the one they perceived. With these two studies the validity and reliability of the Spanish version of WIHIC was established.

In their study, den Brok, Fisher, Rickards and Bull (2005) investigated Californian students' perceptions of their learning environment in 11 Californian schools with 665 science students. They found that self-esteem and attitudes were more positive in the classrooms which were perceived as having more teacher support, task orientation and equity. The study investigated learning environment constructs included in the WIHIC, and in addition student and teacher gender, student ethnic background, socio-economic status (SES) and age. It included the class constructs such as class ethnic composition, class size and school socio-economic status as well. The findings indicated that some WIHIC scales were more tending to measure personal features of student perception of learning environment while some other scales measured more at a class level. The findings also identified the construct that consistently affected student perception, was gender. The study concluded clearly that girls perceived their learning environment in a more positive way than boys.

Fraser (2002) in his review of classroom environment research has specifically discussed the research that addresses associations between student outcomes and the environment and determinants of the classroom environment. He also discussed the differences between teachers' perception and students' perception of classroom environment and the use of qualitative research. Investigations into classroom environment have been replicated in many studies for different cognitive

and affective outcome measures with different samples and instruments. A special group of studies has emerged as a result of the use of information technology in the classroom learning environment, often referred to as technology-rich environments. The next section explores the WIHIC instrument and technology-rich learning environment.

## **3.6 TECHNOLOGY-RICH LEARNING ENVIRONMENT INVESTIGATIONS**

### **3.1.1. INTRODUCTION**

A special area of the investigation of students' perceptions of their learning environment using WIHIC instrument addresses technology rich learning environments. There is an increasing number of studies that have investigated the learning environment with different types of technology: computer-assisted instructions, online learning, web-based learning, using the internet in education, mobile learning, multimedia learning, etc. (Khine & Fisher, 2003).

More and more educational institutions include the internet and webs based learning in their teaching, and therefore evaluate their strategies on incorporating online learning environment. The web signifies a paradigm change in education; it denotes a constant change in learning styles with the information being shared within a wide community (Brodsky, 1998). Many institutions routinely have students' coursework available on-line and the assessment management as well. As the numbers of online courses increase, learning environment research is developing a special field with the focus on technology-rich learning environment. This research investigates the students' perception of their learning environment and the social and psychological aspects of online learning environment.

### 3.1.2. TECHNOLOGY RICH-LEARNING ENVIRONMENT STUDIES

In their study, Chang and Fisher (2003) developed a new instrument the *Web-based Learning Environment Instrument (WEBLEI)* to investigate four aspects of web-based learning environment: Access, Interaction, Response and Results. The first three scales were built on the work of Tobin (1998). The Results scale covers structure and design of online material. The Access scale describes the convenience of accessing the learning activities at the location suitable to the student in an efficient manner and in convenient time. The Interaction scale covers the interaction of the student in the activities to achieve outcomes. The scale Response indicates students' perceptions of their learning environment and their accomplishments of learning objectives in this environment. The Result scale indicates students' ability to determine what they have learned in this specific learning environment. The WEBLEI instrument uses a five-point Likert scale response from Almost Never to Almost Always. The instrument has been administered to two groups of students from the Curtin Business School at Curtin University. The 344 responses were analysed and a factor analysis confirmed the four scales of the instrument. The study validated the instrument and recommended it for use in tertiary education for Web-based learning applications. The WEBLEI, with a small modification, was used by Chard (2010) to investigate students' perceptions of learning in a virtual 3D environment. Skelton (2010) used the WEBLEI in his study to investigate students' perceptions of blended learning environments. Results suggested that students' perception of blended learning environment is positive but also that the online classes were seen as supplemental to and not as a replacement of classroom experience. Snell and Snell-Siddle (2010) in their investigation used a modified WEBLEI for mobile learning environment and named it Mobile-Enhanced Learning Environment Instrument (MOBLEI). The initial results suggested that this instrument is effective in elicitation of information about student perceptions of the new learning environment.

Aldridge and Fraser (2003) stated the importance of having an instrument which will be able to monitor the implementation of Information and Communication technologies (ICT) in the classroom learning environment created by the teachers.

They used the *Technology-Rich and Outcome-Focused Learning Environment Inventory* (TROFLEI). The TROFLEI is a widely used and applicable instrument developed specifically for technology-rich learning environments to investigate students' perceptions of their actual and preferred classroom learning environment. The design of the TROFLEI instrument is based on the WIHIC as it includes all seven WIHIC original scales: Student Cohesiveness, Teacher Support, Involvement, Task Orientation, Investigation, Cooperation and Equity. Three new scales to reflect the technology side of the classroom learning environment were added, namely Differentiation, Computer Usage and Young Adult Ethos. The first version of the TROFLEI instrument had 10 scales with 8 items representing an 80-item instrument. The final version of the instrument contained 77 items in the same 10 scales. The responses on the items were based on a five-point scale with the options of Almost Never, Seldom, Sometimes, Often, and Almost Always. This study also included an innovation in administering questionnaires with two adjacent response scales on the one sheet. The first scale was used to record students' perception of the actual classroom, and the second scale to record students' perceptions of their preferred classroom.

In one study, the instrument was administered to 1,035 students from 80 classes of high school students across different subjects. The investigation focussed on the association between students' perceptions of the learning environment and their academic achievements, and the success of the school in promoting technology-rich and an outcomes-focused learning environment. The result suggested that Equity, Teacher Support and Young Adult Ethos were influencing students' attitude toward their subjects. The results also indicated that computer use attitudes depended on Differentiation and Computer Use scales. The result of investigation into the association between academic efficacy and learning environment perceptions suggested that Involvement, Task Orientation, Investigation and Differentiation account for a significant proportion of variance in Academic Efficacy. In the association between learning environment and achievement, results indicated that only the Equity scale accounts for a significant proportion of variance in student achievements.

In their study, Koul, Fisher and Shaw (2010) validated the Technology-Rich Outcome-Focused Learning Environment Inventory (TROFLEI) in New Zealand settings. They used an 80-item 10 scale instrument administered to 1,027 students from 30 science classes. Among the results it was suggested that female students perceive their learning environment more positively than do males. This study also validated the TROFLEI for New Zealand settings.

Dorman and Fraser (2009) used the TROFLEI to assess 10 classroom environment dimensions. In addition to Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity the following scales were added: Differentiation, Computer Use and Adult Ethos. The Computer Use scale is adapted from the Computer Attitude Scale by Newhouse (2001) and is described as: "the extent to which students are comfortable with and enjoy using computers" (Dorman & Fraser, 2009, p. 83). The findings of the study identified the three strongest predictors of outcomes scale as: Teacher Support predicting Attitude towards subject, Computer Usage predicting Attitude towards computer use and Involvement predicting academic efficacy.

In a study by Margianti (2003), associations between Attitudes and Achievement of university students in computer classrooms were investigated. The study involved 2, 498 computing students in 50 university classes in Indonesia. The WIHIC was used to assess students' perceptions of the university classroom environment. All the scales of the WIHIC were used except the Investigation scale. The Investigation scale was replaced with a modified scale from the Classroom Environment Scale instrument (Moos & Trickett, 1987) named Order and Organization. This scale was considered to be more appropriate for university learning environments and is described as "the extent to which the teacher emphasises that students behave in an orderly, quiet and polite manner, and on the overall organization of classroom activities" (Margianti, 2003, p. 77). An item from this scale is "The teacher decides which students should work together" (p. 77). The results suggested that the learning environment created by the teacher had an effect on the students' attitudes towards the subject. In particular the two scales of Task Orientation and Equity were positively associated with student achievement. An investigation of

the difference between genders indicated that females perceived the learning environment more positively on the Order and Organization, Task Orientation and Cooperation scales than did males. Females also perceived the classroom environment as being less Equitable than did the males.

In another study Zandvliet (2003) investigated emerging Internet (web-capable) classrooms in British Columbia, Canada. The physical and psychosocial learning environment of the classrooms was evaluated using the WIHIC and a *Computerised Classroom Ergonomic Inventory Checklist (CCEI)*. The scales used from the WIHIC were Student Cohesiveness, Autonomy/Independence, Involvement, Task Orientation and Cooperation. The CCEI had five scales: Workspace Environment, Computer Environment, Visual Environment, Spatial Environment and Air Quality Environment. The instruments were administered to 358 high school students in 22 classrooms from six schools. In addition the survey included items for students to rate their satisfaction with learning in this particular environment with a Satisfaction with Learning scale. This scale was adapted from the Test of Science Related Attitudes (Fraser, 1981). Results suggested that students perceived their learning environment positively by allocating high scores on the Student Cohesiveness and Task Orientation scales. The scale Autonomy/Independence scored was rated the lowest of the five scales. It also reported that the level of satisfaction was generally positive. The results of the investigation of the associations between psychosocial factors and satisfaction reported that it was statistically significant and positive on all five WIHIC scales. It also suggested that Task Orientation had the strongest individual association with Student Satisfaction.

Clayton (2003) developed the *Online Learning Environment Scale (OLLES)* to investigate students' perceptions of their online learning environment. The study stated that students' and teachers' perceptions of the learning environment and its impact on the students' performance is as important in the online environment as it is in the classroom. The instrument has eight scales namely Computer Competence, Material Environment, Student Collaboration, Tutor Support, Active Learning, Order and Organization, Information Design and Appeal, and Reflective Thinking and has been validated (Clayton, 2003).

Lang and Wong (2003) in their study developed an instrument called *E-learning Classroom Environment Questionnaire (ELCEQ)*. This questionnaire is designed to evaluate the effectiveness of using e-learning combined with the classic face-to-face learning mode and students' perception of their e-learning environment. The questionnaire was designed with five scales and 30 items. The scales used in this questionnaire were: Investigation, Open-endedness, Organization, Material Environment and Satisfaction. This questionnaire was administered to 134 students from four secondary classes in two schools in Singapore. The questionnaire contained both actual and preferred forms. The response was measured on a five-point Likert scale with the responses from Almost Never to Almost Always. The results suggested that overall, students' perception of their e-learning environments was positive. Actual preferred differences were noted for three of the scales, namely, Organization, Material Environment and the Satisfaction.

She and Fisher (2003) investigated web-based learning environments in Taiwan. The study used two instruments, the Questionnaire of Learning Preference (Lumsdaine & Lumsdaine, 1995) and the WIHIC. The Questionnaire of Learning Preference is based on Hermann's quadrants and consists of 15 items per quadrant. In addition to the WIHIC and the Questionnaire of Learning Preference two more instruments were developed specifically for this study: an e-learning environment questionnaire, namely, the *Web-based Computer Assisted Learning Questionnaire (WBCAL)*, and the *Satisfaction of Web-based Learning (SWBL)*. The results provided the validation for use of these questionnaires in Taiwan. During the use of the flash-based science program students perceived their learning environment to have high levels of Cohesiveness, Task Orientation, Cooperation, Equity and Differentiation. The results also reported students' satisfaction with the program with high scores on the Attitude, Reasoning and Challenging scales. The researchers reported strong relationships between students' perceptions of their learning environment and their web-based computer assisted learning (WBCAL).

Kanokporn and Fisher (2008) investigated associations between tertiary students' attitudes and their perceptions of their computer classrooms learning

environments. They used three questionnaires in the study: the College and University Classroom Environment Inventory (CUCEI), the Computer Laboratory Environment Inventory (CLEI) and the Attitude towards Computer and Computer Courses (ACCC) instrument. The instruments were administered to 905 computer science students. The findings suggested that the modified versions of CUCEI, CLEI and ACCC were valid and reliable instruments for computing laboratory classrooms in tertiary institution in Thailand.

### **3.1.3. SUMMARY**

The section presented a review of research into technology-rich classrooms. It has described the tools used to investigate the perceptions of the technology-rich environment and its effect on student learning, achievement and satisfaction in classrooms. As mentioned, the technology classroom environment is an environment filled with different technologies ranging from laptop to mobile and virtual worlds. However, no study has investigated the attitude towards acceptance of these technologies, and how the learning classroom environment may or may not have influenced that attitude. This study aims to close this gap and uses the WIHIC to investigate the impact of classroom learning environment on students' attitude towards technology acceptance.

### **3.7 RELEVANCE TO THE STUDY**

The WIHIC was selected for use in this study to address the elements of environmental constructs within a classroom setting, and their impact on technology acceptance attitudes. The reason for choosing the WIHIC as the learning environment instrument in my research lies in its generic design, which allows the instrument to be used in any classroom environment. It is relatively new in design, and is based on previous instruments and combines the dimensions that are relevant to today's classrooms (Dorman, 2003). The WIHIC also includes all the scales proven to be significant from the previous use of questionnaires. Because of

this it maps a wider area of learning environments than did previous instruments. Today, it is the most widely used instrument in research investigations into learning environments. It is comprehensive and has been extensively validated by many large studies in Australia, USA, Taiwan, China, Brunei, Canada and India. This cross-cultural validity gives the WIHIC additional strength above country-specific instruments (den Brook, Fisher, Rickards, & Bull, 2005). The instrument has proven to be able to measure students' perceptions of their learning environment and to have predictive validity on cognitive and affective student outcomes (Fraser, 2002). Furthermore it is easy to use and takes a small amount of time for participation.

### 3.8 CHAPTER SUMMARY

The chapter discussed the historical background of the learning environment research and gave an outline of the instruments developed for investigations in this field. The review covered the some of the main instruments such as the QTI (Wubbels & Brekelmans, 1998), the SLEI (Fraser, Giddings, & McRobbie, 1995; Fraser & McRobbie, 1995) , the CLES (Taylor, Fraser, & Fisher, 1997), the WIHIC (Fraser, Fisher, & McRobbie, 1996), and the LEI (Walberg & Anderson, 1968). It also outlined specific research and instruments for technology-rich classrooms environments such as the WEBLEI (Chang & Fisher, 2003) and the TROFLEI (Aldridge, Dorman & Fraser, 2004). It has also identified the need to include WIHIC constructs into the TAM instrument in order to investigate the impact of the classroom environment on students' perceptions and attitudes towards technology acceptance.

In order to capture student attitudes towards technology acceptance in the classroom environment the Technology Acceptance Model TAM has been extended with the WIHIC scales to create a new technology acceptance model which I have named the *Educational Technology Acceptance Model (ETAM)*. As stated previously, there are two reasons for combining the TAM and the WIHIC instrument. First, both of these instruments are generic and can be used for any setting, technology, or user types. Second, both of these instruments have antecedents in motivational

theory and, as such, were logical choices to be combined. The ETAM model is designed to be a generic model for the investigation of acceptance of any technology in educational settings. This model is designed specifically for investigations of attitudes towards technology acceptance within educational learning environments. The ETAM model is explained in detail in the next chapter.

## Chapter 4.

### **DEVELOPMENT OF THE TECHNOLOGY ACCEPTANCE MODEL FOR EDUCATIONAL ENVIRONMENT (ETAM)**

This chapter explains the need for a new technology acceptance model based on the literature review findings on software acceptance in Chapter 2, and on classroom learning environments in Chapter 3. Section 4.1 describes the proposed concept of an Educational Technology Acceptance Model (ETAM). Section 4.2 provides a theoretical analysis. Section 4.3 explains the need for inclusion of learning environmental constructs into a technology acceptance model, and the need for technology acceptance constructs to be included in technology-rich classroom environment research. The section finishes with a list of proposed hypotheses for this thesis. The research methodology is described in section 4.3. The Salsa software used to evaluate the ETAM model is described in section 4.4. The chapter is summarised in the last section.

#### **4.1. THE ETAM MODEL**

The Educational Technology Acceptance Model (ETAM) developed in this study aims to investigate technology acceptance in an educational learning environment. The educational model is designed on the bases of two well established instruments: the Technology Acceptance Model (TAM) by Davis (1986) and the What Is Happening In this Class (WIHIC) (Fraser, Fisher, & McRobbie, 1996). Both of these instruments have been validated and used extensively through many studies over the last three decades.

The first model is the Technology Acceptance Model (TAM) described in Chapter 2 of this thesis. The chapter outlined the theoretical background of the technology acceptance model, based on Davis's original work and identified the criteria for software acceptance. It outlined the historical development of the model and identified the different versions of this model that followed the original version. Many researchers have investigated software acceptance constructs and have

developed different models to address the need for a generic model that will fit different situations (Chang, Hwang, Hung, & Li, 2007). They have investigated different users (Yi, Jackson, Park, & Probst, 2006), different technologies (Davis, Bagozzi, & Warshaw, User acceptance of computer technology: A comparison of two theoretical models, 1989), group decision support systems (Sambamurthy & Chin, 1994), database systems (Szajna, 1994), e-mail (Gefen & Straub, 1997; 2000; Karahanna & Limayem, 2000) and Internet (Moon & Kim, 2001; Yi & Hwang, 2003).

The popularity of Davis's technology acceptance model can be attributed to its simplicity. The model is generic and can be used across different technologies and with a broad range of users (Davis, Bagozzi, & Warshaw, 1989). The technology acceptance model is used to investigate users' attitudes towards acceptance of the technology. The original model developed by Davis (1986) included two dimensions, Perceived Usefulness (PU) and Perceived Ease of Use (PEU). Davis stated that intention to accept or reject a technology is defined by these two factors, Perceived Usefulness and Perceived Ease of Use, only. Davis defined Perceived Usefulness as: "the degree to which an individual believes that using a particular system would enhance his or her job performance" (1993, p. 477). He defined Perceived Ease of Use as: "the degree to which an individual believes that using a particular system would be free of physical and mental effort" (1993, p. 477).

Davis argued that Perceived Usefulness and Perceived Ease of Use influence the formation of behavioural intention to use technology. The *behavioural intention* to use technology would, in turn, form the *actual behaviour* to use the technology. He described the possible influences of the factors when they have been perceived by the user as high and positive, and when they have been perceived by the user as low and negative. If the Perceived Usefulness was seen as positive (high) and the Ease of Use as positive (high), the user was likely to have a *positive intention* to use the technology. This positive intention to use the technology would result in the actual behaviour of using the technology. If, on the other hand, both of these constructs were perceived as negative, it would result in the user forming a *negative intention*. As a result of this negative intention, the person would reject

the use of the technology. If the Perceived Usefulness was perceived as positive, but Perceived Ease of Use as negative, users were still likely to use the technology, believing that it would help with their job task, and consequently improve their performances. If the Usefulness of the technology was perceived as negative, but Ease of Use was perceived as positive, users were not likely to use the technology. The reason for this is that Ease of Use of technology would not motivate the user to accept the technology if it was not perceived as useful. Davis reported that usefulness was significantly more strongly linked to usage of the system than was ease of use. This has been validated in many other studies (Davis F. D., 1993; Davis, Bagozzi, & Warshaw, 1989; Goodwin, 1987; Gould, Boies, & Lewis, 1991; Hill, Smith, & Mann, 1987). The model provided insights into a better understanding of how system characteristics could influence user attitudes towards the software and, consequently, its usage.

Further research identified four more constructs of usage intention and the subsequent user acceptance behaviour: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions (Venkatesh, Morris, Davis, & Davies, 2003). These researchers also used the following moderators: age, gender, previous experience, and voluntariness. The following additional constructs were added by Venkatesh (2000): Computer Self-Efficacy (CSE), Perception of External Control, Computer Anxiety, Computer Playfulness, Perceived Enjoyment, and Objective Usability. Venkatesh, Thong, and Xu (2012) added Hedonic Motivation, Price Value, and Habit. They used age, gender, and experience as moderating factors. Venkatesh and Bala added Computer Playfulness and Effort Expectancy to TAM3 (TAM 3: Advancing the technology acceptance model with focus on interventions Manuscript in-preparation), Agarwal and Prasad (1999) added Tenure in the work place, and Education, Experience and Training. Gefen and Straub (2000) added Task Type and Trust (Gefen, Karahanna, & Straub, 2003). Yi and Hwang (2003) added Learning Goal Orientation. Other researchers included Gender, Task, User Type, and Information System Type (Adams, Nelson, & Todd, 1992; Gefen & Straub, 1997, 2000), Effectiveness (Segars & Grover, 1993), Training (Venkatesh & Davis, 1994), organizational factors such as Computing Support and

Managerial Support (Igbaria & Iivari, 1995), Perceived Playfulness (Moon & Kim, 2001), cultural aspects (Anandarajan, Igbaria, & Anakwe, 2000; Straub, 1994; Straub, Keil, & Brenner, 1997), and User Type (Karahanna & Straub, 1999a; Ridings & Gefen, 2000). In their study Devaraj, Easley and Crant (2008) investigated User Personality with the Five-Factor model and TAM. Venkatesh and Davies added and Investigated Voluntariness (2000). Bagozzi, Davies and Warshaw (1992; Bagozzi & Warshaw, 1990) investigated the Role of Learning. Self-Efficacy, Enjoyment, and Learning Goal Orientation were investigated by Yi and Hwang (2003), and Personal Innovativeness by Agarwal and Prasad (1998). Bhattacharjee and Sanford (2006) investigated influences of external processes. Kim (2010) investigated factors that influence adoption of social media. Kemp (2011) investigated users' intention to use a 3D immersive learning tool in an online learning classroom.

The research on technology acceptance in education has included investigation of digital library system acceptance (Miller & Khera, 2010) where Perceived Usefulness was identified as the main predictor of technology acceptance. Some researchers (Askar & Umay, 2001; Huang & Liaw, 2005; Teo, Lee, & Chai, 2008; Teo, Lee, Ching, & Wong, 2009; Wang & Wilson, 2005; Yildirim, 2000) investigated the impact of the teacher's attitude toward the technology acceptance on the class and on the usage of the technology by the class. Other researchers used the standard TAM to investigate the impact of learners' perceptions on technology acceptance (Brahmasrene & Lee, 2012; Rovai & Barnum, 2003; Shroff, Deneed, & Ng, 2011; Yang, Tsai, Kim, Cho, & Laffey, 2006).

The proposed educational technology acceptance model (ETAM) incorporates the core elements of the original TAM model and extends it with environmental factors. The components of the original TAM model that have been incorporated into the proposed educational technology acceptance model (ETAM), Perceived Usefulness and Perceived Ease of Use, are shown in Figure 4.1.

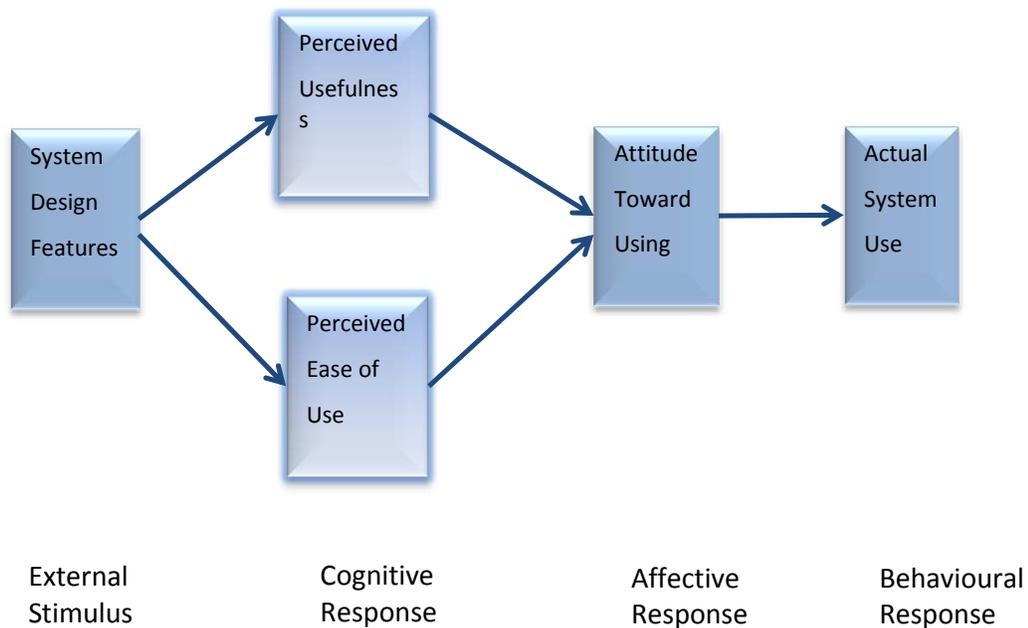


Figure 4-1. PEU and PU constructs of the technology acceptance model TAM in Davis, (1993, p. 481).

The overview of literature has indicated that the use of TAM has been mainly limited to the business environment. In most of the studies presented, students were used to simulate professional users, but the use and acceptance of professional or educational software in their learning environment by the students themselves has not been studied. Where educational software was studied, the focus was on the technology itself: Web-based learning technologies, online teaching and course delivery, course management systems (e.g. Blackboard, WebCT), mobile learning, mobile technologies, and new media. Most studies used either the original TAM model or the UTAUT model in their investigations. They identified and used many new constructs: social ability, readiness, enjoyment, computer efficacy, self-efficacy, trust, confidence, facilitating conditions, etc. The investigation of technology acceptance using the TAM model in the classroom learning environment *per se* has not been studied. Therefore, the part that is clearly missing in the research is to combine learning environment constructs with the technology acceptance model to investigate students' perception of technology acceptance in technology rich classrooms. This new model will allow for systematic

investigations into the effects of environmental factors on technology acceptance by students or teachers, and vice versa. The following section will explain the constructs of the educational environment and the instrument that was used to identify these characteristics of the learning environment. The instrument that has been chosen to investigate the impact of the classroom environment on learning and teaching is *What Is Happening In this Classroom (WIHIC)*. This instrument has been used and validated in many studies and is widely accepted as the most comprehensive instrument available.

### **WIHIC**

WIHIC is an instrument that combines scales from previous instruments that have been proven to be influential on student outcomes and learning (Koul & Fisher, 2006). The instrument measures psychosocial characteristics of the students learning environment. It has been used in the last several decades in different settings, educational levels and countries. Researchers typically used either the original form of the instrument, or a modified version they adapted to fit their specific needs.

Chapter 3 discussed the historical background of learning environment research and gave an outline of the instruments developed for the investigation in this field. The review covered some of the main instruments but, in particular, focussed on instruments used in a technology-rich environment. The review found that the most comprehensive tool used in the learning environment investigation was *What is Happening In This Classroom (WIHIC)*. It also outlined other instruments used for the investigation in the technology rich classrooms environments such as *Web-Based Learning Environment Instrument WEBLEI*, *Technology-Rich and Outcome-Focused Learning Environment (TROFLEI)*, *Place- Based and Constructivist Environment Survey (PLACES)* etc.

Most research into technology-rich learning classrooms has focused on the investigation of students' perceptions of their learning environment. The Web-based learning Environment Instrument (WEBLEI) (Chang & Fisher, 2003) has been used to investigate four aspects of web-based learning environments: Access,

Interaction, Response and Results. The same instrument was used in study by Chard (2010) to investigate student perceptions of a 3D virtual environment, by Skelton (2010) to investigate a blended learning classroom environment, and by Snell and Snell-Siddle (2010) to investigate a mobile learning environment. For the mobile learning environment Snell and Snell-Siddle used a modified WEBLEI named Mobile-Enhanced Learning Environment Instrument (MOBLEI).

The Technology-Rich and Outcome-Focused Learning Environment Instrument (TROFLEI) was used in the investigation of students' perceptions of a technology rich classroom environment (Aldridge & Fraser, 2003; Koul, Fisher, & Shaw, 2010). The TROFLEI instrument has also been used by Margianti (2003) in the university learning environment. Clayton (2003) developed the Online Learning Environment Scale (OLLES) to investigate students' perception of their online learning environment. An instrument designed to evaluate the effectiveness of e-learning, combined with the classic face to face classroom environment, was called E-learning Classroom Questionnaire (ELCEQ) (Lang & Wang, 2003). She and Fisher (2003) used the WIHIC and *Questionnaire and Learning Preferences* instruments to design two new tools *Web-based Computer Assisted Learning Questionnaire (WBCAL)* and *Satisfaction of Web-based Learning (SWBL)* and used it to carry out a study of a web-based learning environment. Hirata and Fisher (2003) used a modified *Classroom Environment Scale (CES)* (Moos, 1974), and Kanokporn and Fisher (2008) used a combination of three instruments to carry out an investigation into a classroom learning environment and students perception of it: College and University Classroom Environment Inventory (CUCEI), The Computer Laboratory Environment Inventory (CLEI), and the Attitude towards Computer and Computer Courses (ACCC).

Zandvliet (2007) developed a new instrument, the Place-based and Constructivist Environment Survey (PLACES) based on the WIHIC, the Science Classroom Environment Survey Learning Inventory (SCES) (Henderson & Reid, 2000), the Science Laboratory Environment Inventory (SLEI) (Fraser, Giddings, & McRobbie, 1995), the Science Outdoor Learning Environment (SOLEI) (Orion, Hofstein, Pinchas, & Giddings, 1994), and the Constructivist Learning Environment Survey (CLES)

(Taylor, Fraser, & Fisher, 1997). This instrument has been validated with the study of Rahmawati, Koul and Fisher (2010). Their study investigated the effectiveness of co-teaching and co-generative dialogue in environmental science classes.

There are many studies that investigated the acceptance of specific technologies in the classroom learning environment, but no study has investigated the influence of the learning environment on technology acceptance. This thesis aims to close this gap. The review in Chapter 3 identified the need for the inclusion of environmental constructs into the technology acceptance instrument to investigate the impact of the classroom environment on students' attitude towards technology acceptance. In order to do this the Technology Acceptance Model (TAM) has been extended with WIHIC dimensions to create a new technology acceptance model which I have named the *Educational Technology Acceptance Model (ETAM)*. The model is designed specifically for investigation of attitudes towards technology acceptance within educational learning environments. This model is explained in detail below.

## **ETAM**

The ETAM model was developed on the basis of two previously developed and used models, namely, the TAM Technology Acceptance Model (Davis F. D., 1986) and the WIHIC (What Is Happening In this Classroom) (Fraser, Fisher, & McRobbie, 1996). The ETAM uses the WIHIC dimensions to investigate the impact of learning classroom environment on attitudes toward technology acceptance. These classroom environment constructs were added to the two technology acceptance constructs (Perceived Usefulness and Perceived Ease of Use) to form a new educational technology acceptance model. This new Educational Technology Acceptance Model (ETAM) which aims to investigate technology acceptance attitude within a classroom learning environment is presented in Figure 4-2.

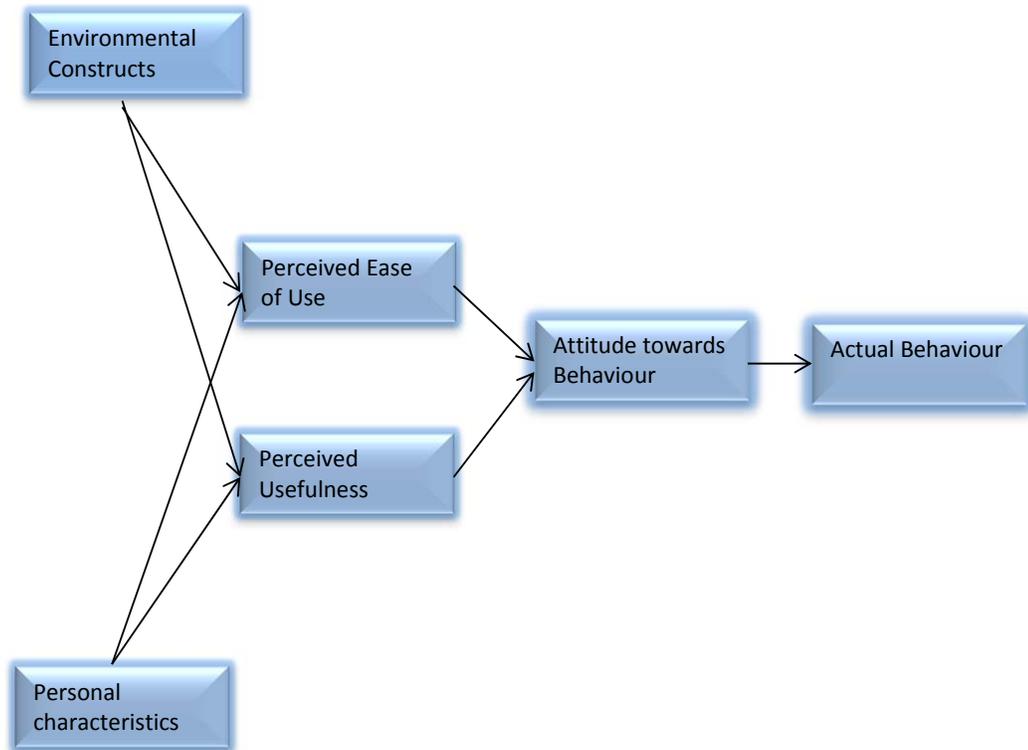


Figure 4-2. Educational Technology Acceptance Model ETAM.

The educational learning environment model ETAM presented in Figure 4-2 has two constructs defined by Davis' original model to investigate the attitude towards the technology acceptance. These constructs are Perceived Ease of Use (PEU) and Perceived Usefulness (PU). *Perceived Ease of Use* is defined as a user's perception of whether or not it is easy to use the particular technology. *Perceived Usefulness* is defined as a user's perception of how much the technology would help the user to perform their job task. The environmental constructs for the educational environment setting are defined by the original WIHIC instrument. The constructs defined and used from WIHIC were: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation, and Student Cohesiveness. Task Orientation is defined as the extent to which is important to complete planned activities and stay focused on the subject. Teacher Support is defined as the extent to which teacher helps and guides students, and is interested in their development and future success. The Investigation construct is defined as the extent to which students are focused on the skills and procedures of inquiry, and their use in problem solving and investigation. The Involvement construct is defined as the

extent to which students participate in the class, are involved with other students in discussing new ideas, and enjoy the class activities. The Equity construct is defined as the extent to which teacher treats students equally, including distributing praise, question distribution, and opportunities to be included in discussions. The Cooperation construct is defined as the extent to which students cooperate, rather than compete, with each other. Student Cohesiveness is defined as the extent to which students are friendly, know each other, and are supportive of one another.

This thesis has used the basic and original versions of both instruments in order to establish and test the general concept of the ETAM. Any other combination of different versions of one or both of these instruments is a task for future research and outside of the scope of this thesis.

This section has discussed the concept of the proposed Educational Technology Acceptance Model (ETAM). It has established the need for this new model in order to investigate technology acceptance in educational settings. The association of the learning environmental constructs with the technology acceptance model constructs are presented in a conceptual path diagram in the theoretical analysis section, which follows.

## **4.2. THEORETICAL ANALYSIS**

The previous section has described the Educational Technology Acceptance Model ETAM, developed for the investigation of technology acceptance in classroom learning environments. The possible associations between environmental constructs adapted from the What Is Happening In this Classroom (WIHIC) instrument with the Perceived Usefulness and Perceived Ease of Use, from the Technology Acceptance Model (TAM), are presented in Figure 4-3. The investigation in this thesis is focused on identifying associations between educational environmental constructs, personal factors, and technology acceptance model constructs. The literature findings of the environmental constructs will be addressed first. The technology acceptance constructs findings, will be presented

second. It will be followed by the findings of the personal factors: age, gender, experience and English language proficiency. The associations for personal factors and the technology acceptance constructs were analysed with the *path* diagram. This diagram is presented in Figure 4-4.

The objective of this study is to increase understanding of the factors that influence technology acceptance in the classroom environment. Software used to explore the attitude towards technology acceptance is Salsa educational software. The Salsa software is described in section 4.4 of this chapter. The technology acceptance model used is Davis' model with two constructs: Perceived Usefulness and Perceived Ease of Use. To these two constructs, seven more constructs have been added in order to investigate the environmental impact of classroom educational settings.

#### **4.2.1. TECHNOLOGY ACCEPTANCE CONSTRUCTS**

##### **Perceived Usefulness and Perceived Ease of Use**

The technology acceptance model used to develop the educational technology acceptance model had the following constructs: Perceived Usefulness and Perceived Ease of Use. Numerous researchers have used original Davis's technology acceptance model or any subsequent modified version of that model in their research. This section will briefly review the findings of the studies from Chapter 2, summarize them, and propose the hypotheses for this study.

Davis (1993) reported in his study that usefulness had twice as strong an effect on use as attitude toward using. In addition usefulness had more than four times the strength of influence on attitude as ease of use. This was inconsistent with the findings of Fishbein and Ajzen (1975). David, Bagozzi, and Warsaw (1989) compared TAM with the Theory of Reasoned Action (TRA) in their study and concluded that computer use by people could be predicted from their intentions; that Usefulness is a major determinant of intentions to use computers, and Perceived Ease of Use is significant secondary determinant of intentions. Ma et al., (2005) found that Perceived Usefulness had a direct significant effect on the

intention to use computers in student teachers. This is comparable with prior studies in different contexts and technologies (Mahmood, Hall, & Swanberg, 2001; Legris, Ingham, & Collette, 2003). Venkatesh and Davis (2000) found that subjective norms had significant effects on intention to use. Ma and Liu (2004) found in their meta-analysis that correlations between Perceived Usefulness and acceptance, and Perceived Usefulness and Perceived Ease of Use, were reasonably strong. The relationship between perceived ease of use and acceptance was weak. King and He (2006) in their meta-analysis outlined the profound influence of Perceived Usefulness and high reliability of Perceived Usefulness and behavioural intention. Their meta-analysis did not include any TAM studies deployed in education, with the exception of students who were used as surrogates for professionals. Two studies (Teo, Lee, & Chai, 2008; Teo, Lee, Ching, & Wong, 2009) carried out an empirical study of TAM in order to validate the Technology Acceptance Model in explaining the intention to use technology among educational users. Their results gave evidence of the effectiveness of the TAM model in predicting the intention to use technology with educational users.

There were numerous studies that found a relationship between learning satisfaction in online learning and social interaction (Rovai & Barnum, 2003; Yang, Tsai, Kim, Cho, & Laffey, 2006). Vonderwell (2003) found that learners who failed to achieve a feeling of community, and felt isolated, were less satisfied with their online classes. Gong et al., (2004) proposed a framework comprised of a combination of TAM and social cognitive theory (SCT) to evaluate IT acceptance by teachers. Meso and Liegle (2005) used TAM to investigate NET as a pedagogical tool for teaching an information systems course. The study suggested that the technology acceptance theory can be used as an approach for assessing the pedagogical fit of specific information technologies for teaching specific information systems courses. The study of Wang et al., (2005) investigated pre-service teachers' attitude toward use of the internet. They found that the use of the internet had been influenced by teachers' confidence level, attitude toward the internet and perceived usefulness as well as friends' support. Gao (2005) stated that the technology acceptance model can be used to evaluate competing products (text

books and technology systems) and as such become a useful tool to educators. The TAM has also been used in investigation of student Perception of Usage, Usefulness, and Ease of Use of web-enhanced instruction (WEI) using Blackboard (Landry, Griffeth, & Hartman, 2006). Moreover, Davis and Wong (2007) used the TAM to analyse students' participation and engagement with an eLearning system. Also, in Saadé (2007) the TAM is used in the context of eLearning systems to investigate the influences of Perceived Usefulness, Performance-Related Outcome Expectations, and Personal-Related Outcome Expectations. Kiraz and Ozdemir (2006) used TAM constructs with six different educational principles and identified 60 different effects on teachers' technology acceptance. Kim et al. (2010) have developed a social media adoption model based on the technology acceptance model's two constructs and added two additional constructs (Perceived Enjoyment and Intention to Use). They have found that Perceived Usefulness, Perceived Enjoyment and Social Influence are important determinants of social media adoption and that Perceived Enjoyment may have greater impact than Perceived Usefulness and Perceived Ease of Use on intention to adopt the social media. Shroff, Deneed, and Ng (2011) investigated students' attitude towards e-portfolio acceptance. Their study showed that Perceived Ease of Use had a significant influence on attitude and a strong influence on Perceived Usefulness. Miller and Khera (2010) investigated the elements of user acceptance of a digital library system in developing countries. They found that Perceived Usefulness was a main predictor of intention to use the digital library. Some other studies addressed learners' perspectives of technology acceptance. Brahmasrene and Lee (2012) investigated the intention of learners to continue online learning programmes. They identified three constructs that defined learners' intent to continue with their online learning: Perceived Social Ability, Online Learning Readiness and Perceived Usefulness.

The main theme that emerges from the studies mentioned above is the central importance of Perceived Usefulness and Perceived Ease of Use in technology acceptance. Many researchers have investigated the effects of these in diverse environments and with diverse users. Overall, the findings suggested that

Perceived Usefulness has the strongest effect on subsequent use of the technology, and that Perceived Ease of Use has an effect on intention to use and on Perceived Usefulness.

In summary, many researchers have used a variant of the Technology Acceptance Model to investigate the acceptance of specific technologies and tools in different environments, including educational settings. They included the basic TAM constructs with new additions, such as Enjoyment or Readiness, and reported their findings for the specific situations. The Technology Acceptance Model allowed for this variety of uses by being generic, and therefore applicable to any technology. Every researcher who used the TAM in an educational environment used two generic constructs: Perceived Usefulness and Perceived Ease of Use. In addition, they added some of the environment constructs which were applicable to their specific environment, but not all of them. As a result, the influence of the educational environment on technology acceptance has not been investigated fully. An instrument that includes all the relevant environmental constructs, and therefore would enable fuller investigation of the impact of the environmental influence on technology acceptance, is the WIHIC. A review of WIHIC findings is presented in the next section.

#### **4.2.2. THE ENVIRONMENTAL CONSTRUCTS**

The WIHIC environmental constructs are: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness. Figure 4-3 shows possible associations of these WIHIC learning environment constructs with the technology acceptance constructs: Perceived Usefulness and Perceived Ease of Use.

Teacher Support, Student Cohesiveness, and Involvement were identified by Moos (1974) as relationship dimensions; Investigation, Task Orientation and Cooperation were identified as personal growth dimensions; and Equity was identified as a system maintenance and system change dimension.

The impact of the learning environment, and its factors in educational settings, has been investigated by many researchers in the last 30 years.

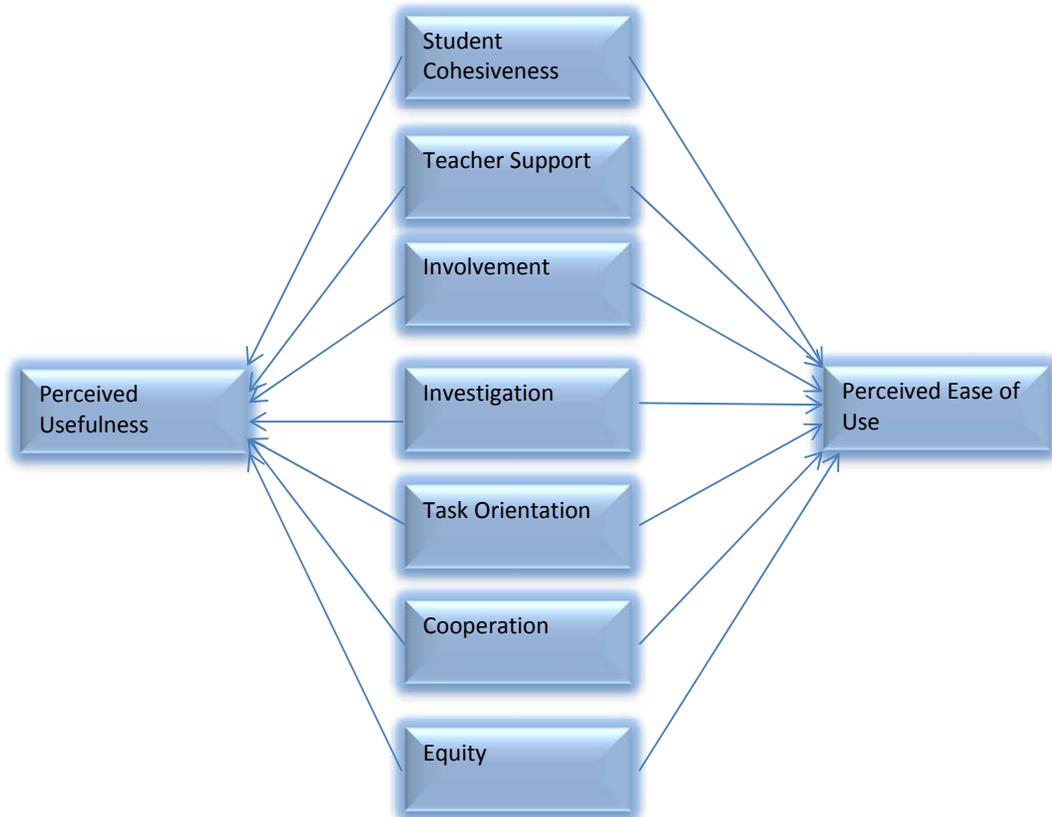


Figure 4-3. Environmental constructs of ETAM model.

Student Cohesiveness has been investigated by Chionh and Fraser (1998) who used the WIHIC to investigate associations between the actual classroom environment and academic outcomes. Their study has shown that better examination scores were found in the classes where student perceptions of the environment were seen as *more cohesive*. An investigation by Zandvliet (2003) suggested that students, overall, perceived their learning environment positively and allocated higher scores for Student Cohesiveness and Task Orientation scales than for other scales. She and Fisher (2003) investigated a web-based learning environment in Taiwan. The results of their study suggested that the students perceived their learning environment to

have high level of cohesiveness, task orientation, cooperation, equity and differentiation.

Teacher Support plays a very important role in the classroom learning environment. Rawnsley and Fisher (1998) used the WIHIC in an investigation of associations between learning environments and student attitude toward the subject in mathematics classrooms in Australia. It was found that students had a more positive attitude towards mathematics in classes where the teacher is perceived as more supportive and equitable, and where students were engaged in investigations. Den Brok, Fisher, Rickards and Bull (2005) investigated Californian student perceptions of their learning environment. They found that self-esteem and attitudes were more positive in classrooms which were perceived as having more Teacher Support, Task Orientation and Equity. Aldridge and Fraser (2003) investigated students' perceptions of their actual and preferred classroom learning environments using the TROFLEI, an instrument, which was developed specifically for technology-rich learning environments. Their findings suggest that Equity, Teacher Support and Young Adult Ethos were the strongest influences on students' attitudes toward their subjects. A study by Dorman, Fisher, and Waldrup (2006) found that all of the classroom environment scales related positively to both academic efficacy and attitude to science. Similar findings were reported previously in Dorman, Adams, and Ferguson (2002) and Fraser (1998), showing positive associations between classroom environments and student outcomes. Research findings suggest that students are more likely to succeed in their studies when teachers *provide support*, demonstrate equity in the classroom, and get their students engaged in the classroom activities. Dorman and Fraser (2009, p. 83) identified teacher support as the strongest predictor of a student's attitude towards a subject.

Involvement has been investigated by Fraser, Fisher, and McRobbie (1996). Their findings suggest that students who were more involved in classroom discussions than the other students were likely to have more favourable perceptions of their learning environment, than those students less involved. Fraser, Pearse, and Azmis (1982) suggested that satisfaction was higher in classes with higher Involvement

and that anxiety has been reduced where students perceived greater differentiation and Involvement. Dorman, Adams, and Ferguson (2002) also reported on findings on the involvement of students in the classroom learning environment. Their findings suggest that there is a positive association between students' involvement and their attitude towards learning. The findings of the Dorman and Fraser study (2009) identified involvement as the strongest predictor of academic efficacy. The author of this thesis believes that the impact of the Involvement (or engagement) may not yet been investigated enough, or not enough attention has been given to it. This reasoning is based on the author's belief, that the student's engagement is a first and necessary step to their success. This engagement should, for students who stay engaged, result in positive outcomes in their studies. This belief is based on both the findings of the studies that investigated involvement and my personal practical experience as lecturer.

The Investigation scale has been studied by many researchers using the WIHIC instrument. An Investigation of associations between learning environments and student attitudes toward the subject in mathematics classrooms in Australia by Rawnsley and Fisher (1998) found that students have a more positive attitude towards mathematics in classes where the teacher is perceived as more supportive, equitable, and students were engaged in Investigations. The author of this thesis believes that the impact of the Involvement and Investigation together, and their association, may not have been given enough attention. This belief is based on my experience as a lecturer. My experience suggests that when a student is involved in an investigation, and is actively looking for the solution to a given task, that the student usually completes the task successfully. It may be that one of the reasons why Involvement and Investigation have not been investigated enough is because we have to have the classes taught by constructivist teachers. These teachers should accordingly, believe that high levels of involvement and Investigation in the classroom is essential for students' success.

Task Orientation has been studied by den Brok, Fisher, Rickards and Bull (2005) who investigated student perceptions of their learning environment. They found that self-esteem and attitudes were more positive in classrooms which were perceived

as having more Teacher Support, *Task Orientation* and Equity. In a study by Margianti (2003), the relationship between attitudes and achievement of university students in computer classroom in Indonesia was investigated. The instrument included all the scales except the Investigation scale. The result suggested that learning environment created by the teacher had an effect on the students' attitudes towards the subject. Two scales, Task Orientation and Equity, had significant associations with student achievement. Zandvliet (2003) also found that students, overall, perceived their learning environment positively allocating higher scores for Student Cohesiveness and Task Orientation scales. She and Fisher (2003) investigated web-based learning environments in Taiwan. Their findings also reported that students perceived their learning environment to be more positive with high level of Cohesiveness, *Task Orientation*, Cooperation, Equity and Differentiation.

The effect of Cooperation on students' perceptions of their learning environment was investigated in a study by She and Fisher (2003). They reported that student learning environment perceptions were more positive when there was higher Cooperation between students.

The Equity dimension of the learning environment has been investigated by Rawnsley and Fisher (1998), den Brok, Fisher, Rickards and Bull (2005), Aldridge and Fraser (2003), Margianti (2003), She and Fisher (2003), and many others. A study of associations between learning environments and student attitudes toward the subject in mathematics classrooms (Rawnsley & Fisher, 1998) found that students had a more positive attitude towards mathematics in classes where the teacher was perceived as more *equitable*. Den Brok, Fisher, Rickards and Bull (2005) found that self-esteem and attitudes were more positive in classrooms perceived by students as having more Teacher Support, Task Orientation and *Equity* (den Brook, Fisher, Rickards, & Bull, 2005). Aldridge and Fraser (2003) suggested that Equity was influencing students' attitude toward their subjects. Analysis of the associations between learning environment perceptions and achievement suggested that only the Equity scale accounted for a significant proportion of variance in student achievements. Margianti (2003) investigated the relationships between attitudes

and achievement of university students in computer classrooms. The results confirmed the findings of previous studies that the learning environment created by the teacher had an effect on students' attitudes towards the subject. The Equity scale was one of two with significant association between student achievement and the learning environment. She and Fisher (2003) investigated web-based learning environments in Taiwan. Their results confirmed the findings of other studies that there was a strong association between students' perceptions of their learning environment and the perceived level of Equity.

In conclusion, the results of many learning environment investigations suggest that the students' learning and their perceptions of the learning environment are associated with learning environment constructs defined in the WIHIC instrument.

The Technology Acceptance Model has also been investigated in the educational environment. There are many studies investigating specifically teachers' attitude toward the technology. The argument for the importance of the teachers' attitude is based on its effect on the technology implementation in the classroom. The research shows that the technology implementation depends strongly on the teachers' attitude. It suggests that when the teacher believes that technology is not beneficial, for them or their students, they would resist the technology implementation into their program (Askar & Umay, 2001). The importance of the teachers' attitude towards the technology, whether this is positive or negative, is that this attitude reflects on student's perception of the importance of the technology (Teo, 2006). Yildirim (2000) found that teachers who used computers more, tended to develop positive attitudes and further promote learning in their classrooms. Research has shown that the attitude toward the intention to use will predict the use itself, and therefore the investigation into attitudes towards computers, as a major predictor of computer use, is important (Myers & Halpin, 2002). Huang and Liaw (2005) stated that the extent to which educational technology will be implemented completely depends on the teacher having a positive attitude.

In summary, it is evident from the research of both WIHIC studies and TAM studies that student attitude toward learning is affected by the learning environment. The strongest influence is expected from teacher support, task orientation, student cohesiveness, and in some cases equity and involvement. It is believed that a positive learning environment is associated with positive learning outcomes for the students. By the same reasoning, this positive learning environment should positively affect the attitude toward technology acceptance. In a classroom environment which is positive and endorses learning in general, it is logical to assume that this positive learning environment will positively affect the intention to learn and use the technology, as part of learning in general. This leads to the following proposition for a hypothesis in this study: that a positive learning environment will positively affect the technology acceptance.

The previous two sections summarized findings of the TAM and WIHIC studies. These two instruments were combined into a unified educational technology acceptance model ETAM. This model is designed to support investigation of technology acceptance in the classroom environment. The ETAM model developed in this study is designed to be generic for the investigation of the acceptance of any technology. It is neither tool nor software specific. In addition this model is designed to be used by any educational participant (teachers or students), and in any classroom environment (primary, secondary or tertiary). There are two reasons for combining the Technology Acceptance Model by Davis (1986) and the What Is Happening In this Classroom (Fraser et al., (1996). The first reason is both of these instruments are generic in the meaning that they can be used in any settings, technology, or user types. The second reason is that both of these instruments have antecedents in motivational theory and as such were the logical choice to be combined.

This section has described the findings and hypothesis proposed for the ETAM model. It has specifically addressed the WIHIC constructs and the TAM constructs. The personal factors investigated in this thesis are explained in the next section.

### 4.2.3. PERSONAL FACTORS AXIOMS

The personal factors of the proposed educational technology acceptance model (ETAM) are: gender, age, experience, and English language. These factors and their associations with the technology acceptance constructs are shown in Figure 4-4.

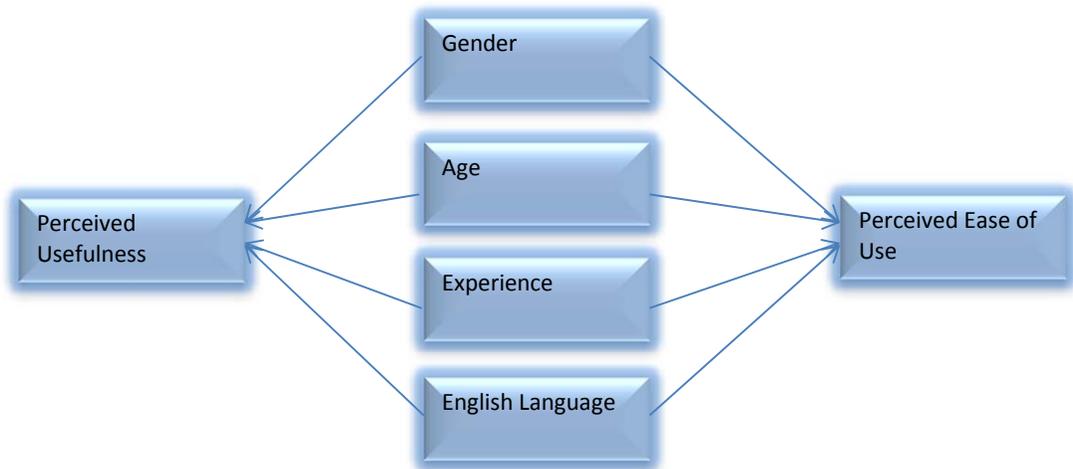


Figure 4-4. Personal Factors of the ETAM model.

Gender has been investigated as a part of the learning environment in many studies (den Brook, Fisher, Rickards, & Bull, 2005; Rahmawati, Koul, & Fisher, 2010; Koul, Fisher, & Shaw, 2010; Margianti, 2003; Zandvliet, 2007). Kim Fisher and Fraser (2000) investigated associations between student attitudes to science and their classroom environment perceptions. Their findings suggested that boys have more positive perceptions of their teacher interpersonal behaviour, their classroom environment, and their attitude toward science classes.

Koul, Fisher, and Shaw (2010) identified gender as a construct that consistently affected student perception and indicated that girls perceived their learning environment in a more positive way than boys. These findings confirmed previous findings that female students perceive their learning environment more positively than do males. Margianti (2003) explained the difference between genders as females perceiving the environment as more orderly and organized, task oriented, and with more cooperation, than males. Females also perceived the classroom

environment as having less equity than males. This particular difference has been attributed to the differences between western culture and eastern cultural beliefs.

Statistically significant differences between male and female students' perceptions were reported in the findings of a study (Dorman & Fraser, 2009) for seven scales: Teacher Support, Task Orientation, Equity, Differentiation, Young Adult Ethos, Attitude to Subject, and Attitude to Computer Use. Female students held more positive perceptions on these scales apart from Differentiation and Attitude to Computer Use.

Khoul and Fisher (2008) reported the findings of their study which suggested that gender difference was significant in only two scales. The female students perceived more positively the Equity and communication of the teacher. Fraser and Dhindsa (2010) reported in their study findings that both female and male students perceived that they were been treated equally.

In their study, Rahmawati, Koul and Fisher (2010) used the PLACES and QTI instruments to investigate the effectiveness of co-teaching and co-generative dialogue in the learning and teaching of environmental science in secondary classes. The result suggested, contrary to other study findings, that the gender difference in perception of the learning environment had not been found.

In conclusion, one can say that most of the researchers of learning environment studies suggested that female students perceived the learning environment more positively than did males. Therefore the following hypothesis is proposed:

*Female perceptions of the learning environment will be more positive than males.*

Gender has been regarded as an important factor in technology adoption and usage. It has been investigated by technology acceptance researchers (Gefen & Straub, 1997; Kemp, 2011; Venkatesh, Thong, & Xu, 2012), as well as learning environment researchers. Venkatesh, Thong, and Xu (2012) used a new UTAUT2 model with the following moderating constructs: age, gender, experience. In their conclusion they stated that Hedonic Motivation was moderated by all three moderators: age, gender and experience. The investigations of Gefen and Straub

(1997) stated that perceived attributes of the system can differ between genders. In the study of Agarwal and Prasad (1998), the perception of the Perceived Usefulness of the system was reported as being different between genders, but not the actual use of the system. Kemp (2011) reported that behavioural intentions correlate directly with the following moderators: age, gender and experience. He found that females showed a weaker correlation between social influences and behavioural intention than did males. He reported that females had stronger and significant correlations in attitude and self-efficacy and that male were more interested in the system impact on the grades (Usefulness) and were less impacted by performance expectancy.

Males were assumed to hold more positive attitudes and be less anxious about technology innovations (Frances, 1994; Gilroy & Desai, 1986; Whitely, 1997). In their study, Ong and Lai (2006) found that men perceived more Usefulness and Ease of Use of an e-learning system. How gender moderates the effect of two key TAM factors on technology adoption would provide a good lens for examining the different decision-making mechanisms between men and women. Several studies showed that men are more likely to be motivated by productivity-related and instrumental factors (e.g., Usefulness), while women are more likely to be influenced by process factors (e.g., Ease of Use) when making technology adoption decisions (Venkatesh & Morris, 2000). These findings were confirmed in other Venkatesh study (Venkatesh, Morris, Davis, & Davies, 2003).

In conclusion, one can say that most of the TAM researchers found that males were more influenced by Perceived Usefulness and females by Perceived Ease of Use. Therefore, these findings were the basis for the hypotheses proposed in the ETAM section.

## **Age**

Age is defined as length of life in this thesis. Age has been investigated by Fraser, Williamson and Tobin (1988), who used the CUCEI with 536 adult learner students from 45 classes in a high school in Australia. Fraser and Treagust (1986) developed

the *College and University Classroom Environment Inventory (CUCEI)* for higher education use. The result suggested that adult returning students perceived their classes as higher in satisfaction, involvement, individualisation and innovation.

Some of the TAM researchers have investigated age as a moderator. In their study, Venkatesh, Morris, and Davies (2003) used age, gender, voluntariness and previous experience as moderators for the following four constructs: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions. The authors argued that these constructs were the determinants of usage intention and behaviour of the user. They reported that the result explained 70% of the variance of the intention to use the technology. Venkatesh, Thong and Xu (2012) used their proposed new extended model UTAUT2 to study technology acceptance in a consumer environment. Their model also included the following moderating constructs: age, gender, and experience. In their conclusion they stated that Hedonic Motivation was moderated by all three moderators: age, gender and experience. Kemp (2011) found that behavioural intentions correlated directly with the following moderators: age, gender and experience. In regard to age, he had found that older students showed a stronger behavioural intention to use the tool based on Performance Expectancies, Attitude and Self-Efficacy. He stated that student attitude toward using the tool become more positive the older they were.

In conclusion, most of the studies reported that older students showed a stronger intention to use the technology than younger ones. Therefore, these findings were the basis of the hypotheses proposed in the ETAM section.

### **Experience**

Experience has been investigated by Venkatesh, Thong and Xu (2012), Venkatesh, Morris and Davies (2003), Venkatesh and Davis (2000) and Agarwal and Prasad (1999). Experience is defined in TAM studies as being familiar with the technology of interest. In this thesis, experience is defined as how the student spent his or her time in the six months prior to the time of the study. Experience is defined as the

nature of life experience. There is some overlap between experience and age which is defined as length of life.

Kemp (2011) found that behavioural intention correlated directly with the following moderators: age, gender and experience. He also found that the more experience users have with technology, the more willing they are to use new technology. Pookulangara (2011) used the TAM3 model with cultural dimensions to investigate consumer-generated-media use. He used experience as a moderating factor with the assumption that users who are more familiar with the technology will be more likely to use the new technology.

In conclusion, one can conjecture that more experienced users would be more likely to use technology than less experienced users. Therefore, these findings were used as a basis for the hypotheses proposed in the ETAM section.

### **Language**

In their study, Soto-Rodriguez and Fraser (2004) used a Spanish translation of the WIHIC administered to 1105 students in grades 2-5. Their findings identified that students with limited English language proficiency perceived their learning environment less positively. Straub and others added and explored cultural aspects in the use of the Technology Acceptance Model (Straub, 1994; Straub, Keil, & Brenner, 1997). They argued that the Technology Acceptance Model has not been tested outside of developed countries and, as such, may not be an appropriate tool for use in developing countries (Anandarajan, Igarria, & Anakwe, 2000).

On the basis of limited evidence, one can conjecture that users with limited English language proficiency would see their learning environment less positively. The assumption is that these users would perceive the usefulness of the technology as more positive than perceived ease of use. Therefore, these findings form the basis of proposed hypothesis in the ETAM section.

#### 4.2.4. ETAM HYPOTHESES

Studies of learning environment have established a strong and positive association between the influence of the learning environment and attitudinal outcomes. Based on these findings, it can be conjectured that the WIHIC constructs will influence attitude toward technology acceptance. A positive learning environment will positively influence attitudes toward technology acceptance. This positive learning environment will positively affect the attitude toward usefulness of the technology. Therefore the following hypothesis is stated:

*H1: Each of the seven WIHIC components will be positively associated with Perceived usefulness*

*H1a: Task Orientation will be positively associated with Perceived Usefulness*

*H1b: Teacher Support will be positively associated with Perceived Usefulness*

*H1c: Investigation will be positively associated with Perceived Usefulness*

*H1d: Involvement will be positively associated with Perceived Usefulness*

*H1e: Equity will be positively associated with Perceived Usefulness*

*H1f: Cooperation will be positively associated with Perceived Usefulness*

*H1g: Student Cohesiveness will be positively associated with Perceived Usefulness*

In particular, the author believes that Teacher Support, Student Cohesiveness, Task Orientation and Involvement will influence very strongly the Perceived Usefulness of the technology.

The Ease of Use constructs are, by analogy with the above hypothesis, predicted as being positively associated with a positive learning environment.

*The hypothesis*

*H2: Each of the seven WIHIC components will be positively associated with Perceived Ease of Use*

*H2a: Task Orientation will be positively associated with Perceived Ease of Use*

*H2b: Teacher Support will be positively associated with Perceived Ease of Use*

*H2c: Investigation will be positively associated with Perceived Ease of Use*

*H2d: Involvement will be positively associated with Perceived Ease of Use*

*H2e: Equity will be positively associated with Perceived Ease of Use*

*H2f: Cooperation will be positively associated with Perceived Ease of Use*

*H2g: Student Cohesiveness will be positively associated with Perceived Ease of Use*

The findings from the literature support the position that females have more positive perceptions of learning environments than do males. However, although females perceived the learning environment more positively, males were more interested in Usefulness. Accordingly the hypotheses with regard to gender are as follows:

*H3: Male perception of Perceived usefulness will be more positive than females.*

*H4: Female perception of Ease of Use will be more positive than males.*

The proposed hypotheses in regard to age factor are:

*H5: Older students will have more positive perceptions of Perceived Usefulness than younger students.*

*H6: Older students will have more positive perceptions of Perceived Ease of Use than younger students*

The proposed hypotheses in regard to the experience factor are:

*H7: Students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience.*

*H8: Students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience.*

The hypotheses in regard to proficiency in the English language are:

*H9: Students with English as a first language will have a more positive perception of perceived ease of use than students with another first language.*

*H10: Students with a non-English speaking background are likely to have higher perception of Perceived Usefulness than English speaking background students.*

This section has stated all the hypotheses proposed for this thesis. The next section will describe the methods used to test these hypotheses.

### **4.3. METHOD**

This thesis has developed a new Educational Technology Acceptance Model (ETAM). The central proposition of ETAM is that environmental factors are an important consideration in the evaluation of software acceptance. To evaluate this model, student and lecturer attitudes towards a specific software package, Salsa, were studied. A brief overview of the Salsa software is given in section 4.4. The context of the study was the use of educational software in computing classes in tertiary programmes of study in a large metropolitan polytechnic in Auckland, New Zealand. Both lecturer and student perceptions were investigated.

To gather lecturer perceptions, semi-structured interviews were carried out with the lecturers teaching the courses. The lecturers teaching the courses were invited to participate in this study. A participant information sheet (PIS) was given to each invited lecturer. The lecturers who chose to participate in the study were invited to sign consent forms. The signed consent forms were treated confidentially but not anonymously (the identities of the lecturers were known to the researcher). The interviews were audio taped in scheduled sessions. Audio recordings were transcribed by a third party.

To gather student perceptions, a purpose-written questionnaire was developed. This was tailored to the Salsa software used. The questions were organised into two scales, corresponding to the perceived usefulness and perceived ease of use constructs from TAM, and to the seven subscales from WIHIC: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness. Students in classes where the Salsa software was used, the course lecturer had given consent, and there was no teaching relationship between the researcher and the students, were invited to participate in the study. Their participation was voluntary. A participant information sheet was given to all invited students. Students who chose to participate were given the paper questionnaire to complete. The questionnaire was anonymous. The questionnaire was administered and collected by the researcher in the invited classes, independently of the lecturers. The data collected by the questionnaire were entered into the computer program by the researcher, for analysis.

### **Analysis**

A quantitative approach was used to analyse the student questionnaires. A quantitative methodology is appropriate for the questionnaire because the number of responses (208) is adequate for quantitative analysis. The analysis involved formal statistical testing of a number of hypotheses. The hypotheses tested are shown in Table 4.1

Table 4.1.

ETAM Hypotheses

Hypothesis	
H1a	<i>Task Orientation will be positively associated with Perceived Usefulness</i>
H1b	<i>Teacher Support will be positively associated with Perceived Usefulness</i>
H1c	<i>Investigation will be positively associated with Perceived Usefulness</i>
H1d	<i>Involvement will be positively associated with Perceived Usefulness</i>
H1e	<i>Equity will be positively associated with Perceived Usefulness</i>
H1f	<i>Cooperation will be positively associated with Perceived Usefulness</i>
H1g	<i>Student Cohesiveness will be positively associated with Perceived Usefulness</i>
H2a	<i>Task Orientation will be positively associated with Perceived Ease of Use</i>
H2b	<i>Teacher Support will be positively associated with Perceived Ease of Use</i>
H2c	<i>Investigation will be positively associated with Perceived Ease of Use</i>
H2d	<i>Involvement will be positively associated with Perceived Ease of Use</i>
H2e	<i>Equity will be positively associated with Perceived Ease of Use</i>
H2f	<i>Cooperation will be positively associated with Perceived Ease of Use</i>
H2g	<i>Student Cohesiveness will be positively associated with Perceived Ease of Use</i>
H3	<i>Male perception of Perceived Usefulness will be more positive than females.</i>
H4	<i>Female perception of Ease of Use will be more positive than males.</i>
H5	<i>Older students will have more positive perceptions of Perceived Usefulness than younger students.</i>
H6	<i>Older students will have more positive perceptions of Perceived Ease of Use than younger students</i>
H7	<i>Students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience.</i>
H8	<i>Students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience</i>
H9	<i>Student with English as a first language will have a more positive perception of Perceived Ease of Use than students with another first language.</i>
H10	<i>Students with a non-English speaking background are likely to have higher perceptions of Perceived Usefulness than English speaking background students.</i>

The broad approach to testing these hypotheses is correlational and first order correlations were investigated. To determine the unique contributions of each component, path analysis and multiple regressions were used. The path analysis used the model which was presented in Figure 4-3. and Figure 4-4. ANOVA was used to explore the effect of categorical variables such as gender and experience. The full analysis of student perceptions is presented in Chapter 6.

Lecturer perceptions were analysed by using a qualitative methodology. The transcript analysis was performed by applying thematic analysis. The full analysis of the lecturers' interview transcripts is presented in Chapter 5.

### **The sample**

The study had two samples: the student sample and the lecturer sample. The students sample comprised students from courses using the Salsa software who chose to participate. The instrument was administered to students in ten classes over two semesters; five classes in the first semester and five classes in the second semester. The classes were in computer science, information technology, multimedia and business computing. From these classes, 208 students' responses were collected. The student sample is described in more detail in Chapter 6.

The lecturers who were teaching the classes were invited to participate in a semi-structured interview. In total, four lecturers participated in individual interview sessions. The lecturer sample is described in more detail in Chapter 5.

### **The instrument**

The instrument used to capture the student perspective was combined from two sources. The original technology acceptance model (TAM) by Davis (1986) with two basic constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PEU), was extended with environmental constructs. The environmental constructs were taken from the What Is Happening In this Class (WIHIC) (Fraser, Fisher, & McRobbie, 1996) instrument. These constructs were then integrated into the TAM and administered to the students in this study. The WIHIC instrument was chosen as it is considered

to be the most comprehensive and widely-used instrument for investigation of student perceptions of the educational environment.

The items of the Perceived Usefulness scale were based on students' experience with the software use and required the students to indicate how useful they have found the features of the Salsa software to be. Perceived Ease of Use was measured on a scale from: Very difficult, Difficult, OK, Easy, and Very easy. Perceived Usefulness was measured on a scale from: Not useful at all, Little use, Some use, Fairly useful, and Very useful.

The WIHIC instrument scales included in the instrument were: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness. All the responses for all the items on these scales were measured with a five point scale: Never or Almost Never, Rarely, Sometimes, Often, and Almost or Almost Always. The complete questionnaire is presented in Appendix A of this thesis.

### **Qualitative method**

The lecturer perceptions of technology acceptance were investigated qualitatively. The instrument used comprised semi-structural interviews. These aimed to capture the lecturers' perceptions of the technology acceptance in their classroom. Perceived Usefulness and Perceived Ease of Use were investigated in the interviews. The study by Dorman and Fraser (2009) suggested that teacher attitude had a strong effect on students' attitude; therefore teacher attitude and perceptions were investigated. The interviews were used as an instrument that can capture the richness of the information and can accommodate for the small number of participants accordingly. The full analysis of the lecturers' perceptions is presented in Chapter 5.

This section has described the reasons for the methodology used in the study and reasons why they have been chosen. It briefly described the sample and the instruments. The software used to evaluate the ETAM model is described in the following section.

#### 4.4. SALSA SOFTWARE

The Salsa software (Lopez, 2005) used to evaluate the ETAM model is described in this section. The software is used to help students to support and manage their own learning. It is designed to give feedback to the student, and to the tutor, on how the student is progressing with the course. It has two modules: the Lecturer module and the Student module.

##### **Lecturer module**

The lecturer module is designed to allow lecturers to enter the course material into the Salsa software, and to monitor students' success. Tutors use the Salsa software to monitor and manage students' requests for help, and to monitor the learning progress of students.

First, the lecturer designs the course and enters all the topics of the course into the Salsa software. The topics are units of learning that usually relate to a single theme or idea. All topics have a scheduled start date and expected learning hours. Assessment items may also have a due date.

Each topic has a set of learning activities (the things that students are expected to do) and set of intended learning outcomes (the things that students are expected to learn from carrying out the learning activities). For the activities, there are three option columns that a student can tick to report their status: Started, Need help and Completed. For learning outcomes there are also three columns: Partly, Need help and OK. This course description includes general information about the course and syllabus, and information about the topics covered. All topics are mapped to syllabus items, in an order that follows the logic of the course and building blocks within it. All topics are associated with their intended learning outcomes, and expected learning activities. A list of the course topics with a graph indicating the overall progress of the class is shown Figure 4-5.

Students					
Topics					
All items					
Help items					
Heat map					
	Topic	Activities	Outcomes	Handled	Need help
▶	Select			27	62
	Where			4	79
	Joins				90
	Union and Subqueries			1	108
	Aggregates				63
	Updating				42
	SQL Test				36

Figure 4-5. Class progress graph.

Once the course and the students' names are loaded into the software and students have been given rights to use it, monitoring of students' learning progress can start from the beginning of the first week of the semester. By submitting self-reports, students regularly update their status to reflect their progress in the course. The shape of the report is explained in the student module. Colour coding is used to quickly identify the support required from the lecturer. The green colour represents a student, who has started on the activity and needs more time, the blue colour represents students who have completed the activity, the red colour represents students who have asked for help on the item, the yellow colour represents the students who have asked for help and the tutor has responded, and the grey colour represents students who have not yet started the activity. The individual students' progress and needs are shown in Figure 4-6. This figure would normally display a list of the students' names in the first column; these have been removed because of privacy considerations. The columns Activity and Outcome status indicates students' progress on the expected learning activities and the intended learning outcomes. The flag column is for arbitrary lecturer use, and is often used to indicate whether the lecturer needs to discuss matters with the student, or send an email, etc.

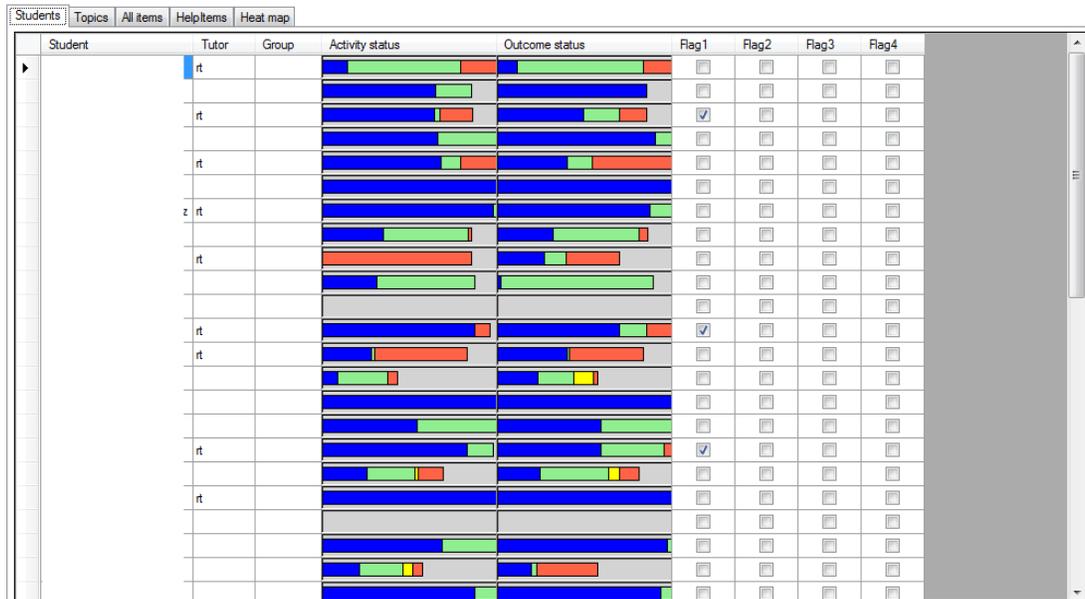


Figure 4-6. Individual student progress.

Another useful feature in diagnosing students in need is the “heat map”, which summarises student progress by topic in a colour code. It is used to identify students who may be struggling with many topics, and topics that may be challenging many students. A sample of a heat map is shown in Figure 4-7.

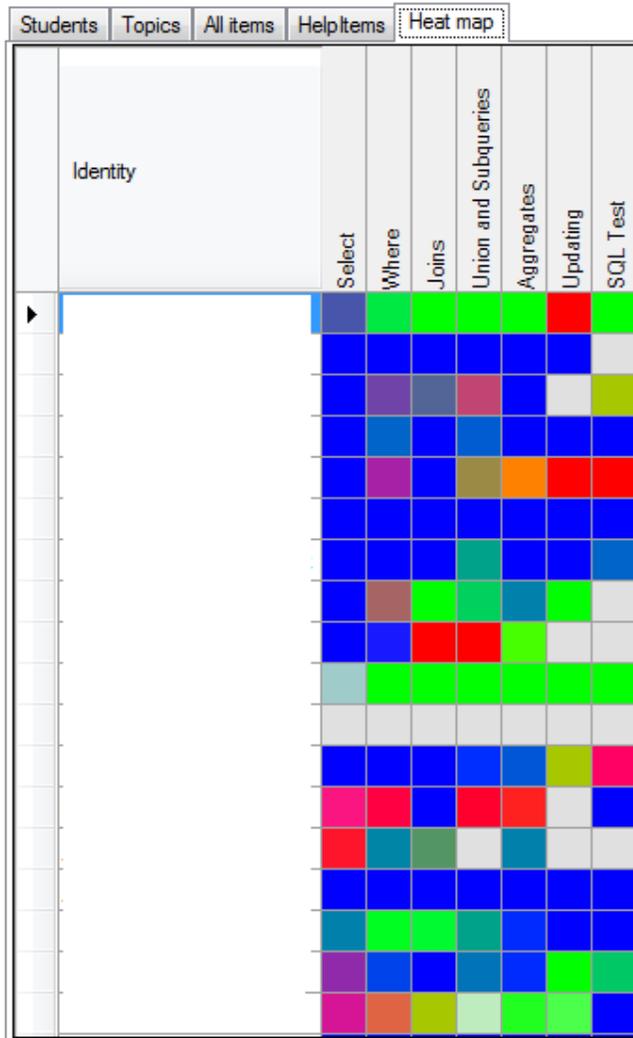


Figure 4-7. Student understanding of course topics - heat map.

A lecturer can also view information about a student’s participation in the learning session with a history of that participation. Figure 4-8 shows a list of the students (with names removed for privacy reasons) and their participation in the session with the time and date. The status of each student’s progress in the session is also displayed.

Students needing help		All students		Student	Tutor	Group	Status	Code	History
					rt		Completed	█	Started and completed on 2-Sep.
							Completed	█	Started and completed on 5-Aug.
					rt		Completed	█	Started and completed on 12-Aug.
							Completed	█	Started and completed on 29-Jul.
					rt		Completed	█	Started and completed on 29-Jul.
							Completed	█	Started and completed on 29-Jul.
					rt		Completed	█	Started and completed on 29-Jul.
					rt		Need help	█	Started and asked for help on 12-Aug.
							Completed	█	Started and completed on 5-Aug.
					rt		Completed	█	Started on 29-Jul; completed on 12-Aug.
					rt		Completed	█	Started and completed on 5-Aug.
							Started	█	Started on 29-Jul.
					rt		Completed	█	Started and completed on 29-Jul.
							Completed	█	Started and completed on 29-Jul.
							Completed	█	Started and completed on 29-Jul.
							Completed	█	Started and completed on 5-Aug.
							Completed	█	Started and completed on 29-Jul.
					rt		Completed	█	Started and completed on 5-Aug.
					rt		Need help	█	Started and asked for help on 2-Sep.
							Completed	█	Started and completed on 29-Jul.
							Completed	█	Started and completed on 29-Jul.

Close    ⏪    ⏩    ⏴    ⏵    Item 2 of 115

Figure 4-8. Student participation in the learning session and status.

The student view of the software is called the student module and is described next.

### Student module

The student module in Salsa software is used to support students in their own learning. Students log in to the Salsa software regularly, and update their learning status. The software is available on the web and in the laboratories of the practical classes.

The module contains information about the courses that the student is enrolled in. Students click on the course in order to get in, and then choose from the list of the topics available for the course.

The basic organisational unit in the Salsa software is a course. An educator uses the software to prepare an extended electronic course descriptor, and to identify the students who may use the course in Salsa. Students then use the web-based Salsa software to file status reports, request assistance, and monitor their learning progress. After logging in, students are presented with a list of the Salsa courses available to them. Selection of a course presents the students with an overview of the course, including progress by topic. From this overview, students can view graphical representations of their learning progress, and status reports. Students record and report their learning progress by selecting a topic and updating the status of the various learning activities and outcomes. A sample of the screen that students see for a topic is shown in Figure 4-9.

The screenshot displays a software interface for "Week 1" titled "Introduction to the course and Visual Studio and Visual Basic.Net". It is divided into two main sections: "Learning activities" on the left and "Learning outcomes" on the right. Each section has a progress bar at the top with three colored segments (blue, green, red) and a legend below it. The "Learning activities" legend includes "Started", "Help", and "Done". The "Learning outcomes" legend includes "Partly", "Help", and "OK".

**Learning activities:**

- Reading chapter 1
- Read lecture notes 1
- Read lab notes 1
- Week 1 exercises - exercise 1.
- Week 1 exercises - exercise 2.
- Week 1 exercises - exercise 3.
- Week 1 exercises - exercise 4.
- Week 1 exercises - exercise 5.

**Learning outcomes:**

- Can create a VB project with a simple form
- Understand the button control
- Understand the label control
- Understand the textbox control
- Can write code to handle an event

A "Close" button is located at the bottom center of the interface.

Figure 4-9. Student self-reporting.

There are two sections in this figure. The expected learning activities are shown on the left section and, and the expected learning outcomes are shown on the right section. Students report their status by clicking on the applicable status box in each section. Each section uses three boxes.

The *started* box is clicked when students have started the activity, the *help* box when they have started the activity but need help to complete the activity, and the *done* box they click when they have completed the activity. The default status is *not started*, and clicking on a ticked start box resets the status to this value to accommodate any error in data entry. The colours used in the section represent counts of the number of activities in each status: completed (blue), started (green), need help (red) and not started (grey).

For the learning outcomes section, students click the *partly* box when they believe they can mostly carry out the task but are not confident they can do it always, or they have some understanding of the concept, but do not believe they have understood it fully. Students click the *help* box when they believe they need help with the task or concept. They choose the *OK* box when they understand the concept, or can do the task. The default status is *not understood* (or cannot do). Clicking on a ticked *partly* box resets the status to this default value to accommodate any error in data entry. Because these are self-report data, the use of terms like *understand* is appropriate. The normal language used for assessed learning outcomes would not allow the term understand (as an unobservable factor) to be used but since this is self-report it is appropriate. The coloured bar at the top of the section represents counts of the number of outcomes in each status: confident (blue), partly (green), need help (red) and not understood (grey).

This section has briefly described the Salsa software used in this study to evaluate the ETAM. The description covered two modules lecturer module and student module. The lecturer module enables the lecturer to monitor student progress and intervene when either help was required by the student, or on his/her own initiative. The student module enables students to monitor their own learning progress and to ask for help (when needed) in a very confidential manner. The most important advantage of this tool, from the lecturer point of the view, is to give the lecturer reason to approach the student and to talk with the student, using the reports as a basis for this discussion.

#### 4.5. CHAPTER SUMMARY

The chapter has described the development and the concept of the Educational Technology Acceptance Model, ETAM. It has proposed the hypotheses of the study and identified the methodologies by which these hypotheses will be tested. The student perceptions of the technology in an educational classroom environment are evaluated with a questionnaire. The structure of the instrument, incorporating both technology acceptance scales and educational environment scales, has been briefly described. The perceptions of the lecturers were evaluated by semi-structured interviews. The reason for choosing a qualitative methodology was its ability to capture the richness of the information and also to accommodate small numbers of participants. The sample, the instrument and ethical considerations were briefly explained. The Salsa software used in validation of the model has been briefly described.

## Chapter 5.

### **LECTURER PERSPECTIVE**

#### **5.1. INTRODUCTION**

Many studies have investigated teachers' attitudes toward technology. The teacher's attitude has been seen as the most influential factor on which the success of any technology implementation in education strongly depends (Askar & Umay, 2001). Research studies suggest that teachers will resist a technology implementation if they believe that the technology is not beneficial for them or their students (Askar & Umay, 2001). The importance of the teacher's attitude towards the technology, whether this is positive or negative, is that this attitude reflects on students' perceptions of the importance of the technology (Teo, 2006). Yildirim (2000) found that teachers who use computers more, tend to develop positive attitudes and further promote its use in teaching in their classrooms. Huang and Liaw (2005) stated that the extent to which educational technology will be implemented depends completely on the teacher having a positive attitude.

This chapter investigates the lecturers' perception of technology acceptance within a classroom environment, as measured by the ETAM. The software, Salsa, is used to evaluate the ETAM. The lecturers' perceptions were analysed by using a qualitative methodology. Interview transcripts were analysed by applying thematic analysis. The ETAM was used as an analytical framework for the analysis of these interviews.

The chapter is organised as follows: it starts with a description of the method and the lecturer sample. This is followed by a full analysis of the lecturers' interviews which is presented in two sections. The first of these sections describes the qualitative analysis of lecturers' interviews of the technology acceptance constructs of the ETAM (Perceived Usefulness and Perceived Ease of Use). The second section describes the qualitative analysis of the environmental constructs of the ETAM. The following environmental constructs were used for the analysis: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student

Cohesiveness. This section is then followed by a discussion of the strengths and weaknesses of the ETAM as an analytical framework for thematic analysis. The chapter finishes with a summary.

### **5.1.1. METHOD**

To gather lecturer perceptions, semi-structured interviews were carried out with the lecturers teaching the courses. The interviews were structured around the concepts of Perceived Usefulness (PU) and Perceived Ease of Use (PEU), with some additional questions that followed. Each interview took approximately one hour. The interviews were scheduled in a special room and audio taped. The audio recordings were transcribed by a third party. The tapes will continue to be kept in a locked cabinet and destroyed in seven years. The transcripts of the interviews are kept on the computer protected by a password. They also will be erased in seven years. Only the researcher and the supervisor of the thesis have access to the content of the interviews. The lecturers were invited to participate. Only the lecturers who agreed to participate and signed the consent forms were interviewed. Again, these forms will be kept for seven years and then destroyed.

### **5.1.2. THE INSTRUMENT**

The semi-structured interviews were designed around two basic topics; perceived usefulness and perceived ease of use. The reason why the focus was on these two selected topics only is the fact that in the interview the number of the topics should stay limited. The limitation of the numbers of topics for interviews is important to ensure that the richness of the data, and the feelings and the emotions of the participants, could be better captured during the process of the interview. Having a larger number of topics results in an interview becoming like a questionnaire, resulting in a lot of short answers. The short answers would not reveal much of the feelings and emotions behind the answers, and therefore, defeat the sole point of having the interview in the first place. In conclusion, because of the reasons

explained above, the interviews have been focused on only two topics, namely, Perceived Usefulness and Perceived Ease of Use.

A typical question in regards to usefulness would be: “And I would like first of all for you to talk about how you feel about it. What is your experience of usefulness?” or “How useful was it for you as a lecturer to get all that information about the progress of the students?” This question would be then followed with: “If you could talk about your own view, observations and how students felt about the usefulness of the Salsa?”. Typically questions would address both views, the lecturer’s view of the Perceived Usefulness of the software in the class, and the lecturer’s perception of how useful was this software to their students and students’ management of their own learning.

Similarly the questions about ease of use would be: “How easy was it to use?”. First, the lecturer’s point of view would be discussed, and then the lecturer’s Perception of student Ease of Use of the software would be discussed. Typical question would be: “Can you tell me when you looked at your students, was it easy for them to use it?”

The interview would then take a different course with the different lecturers. The role of the interviewer was to let the lecturer to take the lead in the discussion and the questions were formed on the basis of the topic that the lecturer would suggest. In some interviews, we would talk more about students and changes needed in the software, to make it function better. With others, the interview would go into a discussion on feedback and an intervention. For some of the lecturers, the interviews showed the students taking ownership of their own learning, and life-long learning, so how to learn was the most important part. So in conclusion the interviews were semi-structured and only two topics were planned and executed, during the interviews, the rest of the interviews were left to take they own courses.

After the transcript of the interviews, all the interviews were sent to the lecturers to check that the transcript of their interviews was correct and a true and fair

representation of their opinions. All lecturers agreed that the interviews were correct and a fair representation of their opinions.

### **5.1.3. THE SAMPLE**

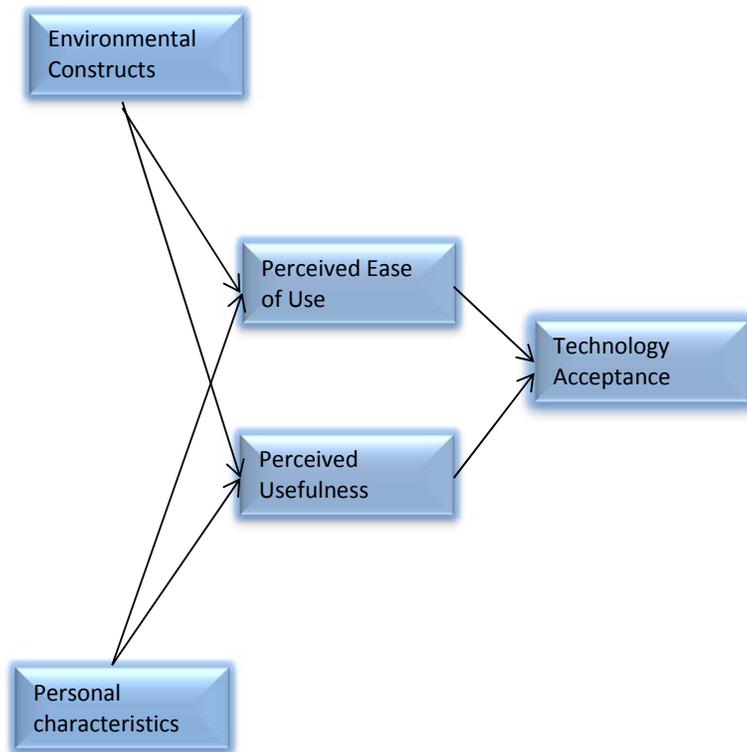
The lecturers teaching the courses were invited to participate in this study by taking part in the semi-structured interview. A participant information sheet (PIS) was given to each invited lecturer. Those lecturers who chose to participate in the study were invited to sign consent forms. The signed consent forms were treated confidentially but not anonymously (the identities of the lecturers were known to the researcher). In total, four lecturers participated in individual interview sessions. These lecturers were involved with a total of five classes over two semesters. One of the lecturers was teaching two classes.

Thus, the sample for this qualitative analysis comprised four lecturers from the computing degree in an Auckland, New Zealand, polytechnic. Lecturer 1 was a male senior lecturer in the computing department who specialised in hardware and networking and had ten years of experience in teaching. Lecturer 2 was a male senior lecturer in the computing department who specialised in systems and programming, with 30 years of teaching experience. Lecturer 3 was a female lecturer with five years of experience, who specialised in multimedia. Lecturer 4 was a male senior lecturer with 14 years of teaching experience who specialised in programming.

### **5.2. THE ANALYSIS**

This section presents the lecturers' perceptions of the Salsa software, analysed with the ETAM analytical framework. The model is combined from two well established and widely used models from two major research domains: the Technology Acceptance Model (TAM) and the educational environment instrument What Is Happening In this Class (WIHIC).

The full description of the ETAM was given in Chapter 4 section 1, and is displayed in Figure 5-1. The analysis in the following section presents the lecturers' perceptions of the technology acceptance constructs: Perceived Usefulness and Perceived Ease of Use.



*Figure 5-1.* The constructs of the ETAM.

This study uses thematic analysis and the ETAM framework to analyse the lecturers' perceptions of the use of Salsa software in an educational environment. Thematic analysis is defined as the process of segmentation, categorization and relinking of aspects of data prior to final interpretation (Matthews & Ross, 2010). Working with qualitative data means getting a good understanding of the words, stories and explanation of accounts from our participants.

The ETAM framework is used to analyse the lecturer interviews. The main elements were the two of the ETAM framework constructs, namely Perceived Ease of Use and Perceived Usefulness. These constructs were analysed from two perspectives. The first perspective was the perception of usefulness from the lecturer side. In other words does the lecturer perceive the software as useful to the students, and

the other, does the lecturer believe that a student perceives the software as useful? The same analogy applies to the Perceived Ease of Use construct. It has also been analysed from both perspectives, does the lecturer perceive the software to be easy to use and does the lecturer believe that student perceives it as easy to use. In addition the analysis included environmental and personal constructs of the ETAM framework as well.

### 5.3. THE TECHNOLOGY ACCEPTANCE CONSTRUCTS

The analysis started with the broad structure of identifying the two basic ideas in the transcripts: the technology acceptance and educational environmental constructs. The technology acceptance analysis started with the basic concept of identifying the perceptions of the lecturers of Perceived Usefulness and Perceived Ease of Use of the software used in the classroom. The ETAM analytical framework was used for this qualitative analysis. The analysis starts with the description of the lecturers' perception of the Perceived Usefulness and it is followed by the lecturers' perception of student Usefulness of the software. Similarly, the lecturers' perception of the Ease of Use of the software is presented followed by the lecturers' perception of students' Ease of Use of the software.

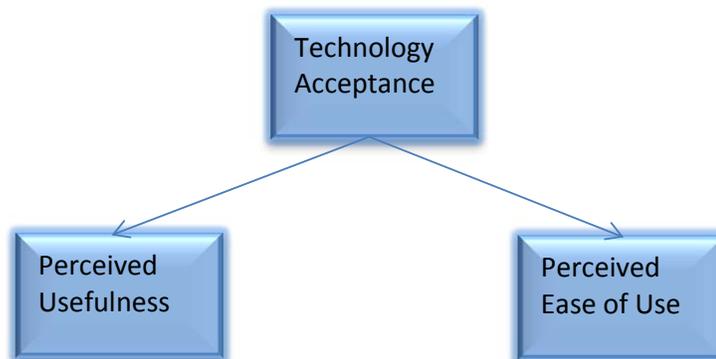
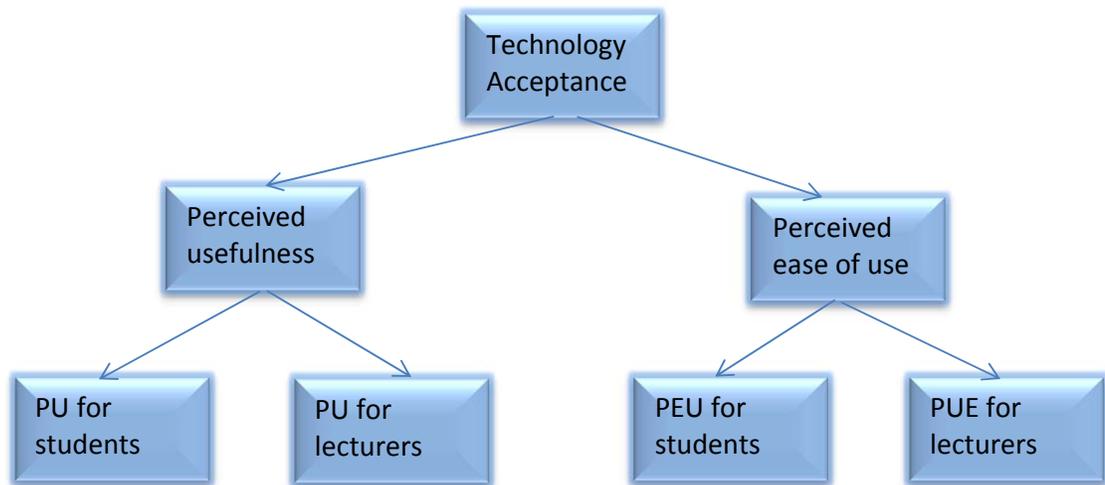


Figure 5-2. The technology acceptance constructs.

The first analysis looked for Perceived Ease of Use and Perceived Usefulness in general, regardless of whether it was describing the lecturers' or students' perceptions. All data were coming from the lecturers but the lecturers were talking

about both, their own perceptions, and the students' perceptions they observed in the classrooms. So the next logical step was to identify which was a description of students and which was a description of the lecturers' own perception of perceived ease of use and perceived usefulness. This step is presented in Figure 5-3.



*Figure 5-3.* The technology acceptance constructs PU and PEU from the lecturer perspective and student perspective, perceived by the lecturer.

The beginning of the analysis included only the lecturer PU and PEU. It was very clear that lecturers had their own perspective of PU and PEU but also the lecturer had perceptions of the students' PU and PEU. Therefore, the qualitative analysis required the separation of the Perceived Usefulness scale into two parts: lecturer Perceived Usefulness and students' Perceived Usefulness from the lecturer perspective. Similarly, the Perceived Ease of Use has been divided into two scales as well, lecturer Perceived Ease of Use and student Perceived Ease of Use from the lecturer perspective.

### 5.3.1. PERCEIVED USEFULNESS

#### Lecturer number one

#### Lecturer usefulness

Perceived Usefulness described by the lecturers varies from useful to not useful. Lecturer One has described his perception of the usefulness of the software in his classroom as:

*So for me, if I want to talk about myself, it wasn't really very useful for me. I checked it three or four times. I find it easier if I just target the students I feel are weak and sit beside them or answer their questions rather than this indirect way.*

Lecturer One feels that the software is not working for him. He feels that students do not need this “indirect” way of communication because he is happy to work with them on an individual basis and feels that he is supporting his weak students in this way. There may be different reasons for these feelings. One of the reasons may be that he did not have enough time to follow up with the students’ requests and instead of reading reports; he just asked what the problem was. This is a very good way of communicating and interacting with the students who are comfortable talking directly about the problems, but may not be that good for the students who shy away from direct communication. The most common reason why the lecturer did not have enough time to follow-up on the students’ software reports, could be fairly high lecture work load at the time of data collection. This high workload did not allow the lecturer adequate time for class preparation and certainly not enough time for any additional activities. This could result in the lecturer not being comfortable with the software use himself, and therefore not being able to utilise it properly. All this would result in this lecturer’s belief that the software is not really useful for him and this would certainly project onto his students and impact on the students’ perceptions of the same software. Therefore, the students would create a perception of the software usefulness as influenced by the lecturer’s perception. This influence would have affected not only students’ perceptions but also the actual use of the software itself.

At the same time, this same software was seen as useful by the lecturer in: helping him to diagnose the students' ability to learn, and to differentiate the high achiever from low achiever groups. This was particularly helpful at the beginning of the course when the lecturer's knowledge of the students' ability is limited.

### **Lecturer one perception of the software's usefulness for the students**

This lecturer also felt that the students were not taking the software tool seriously:

*And I know the majority of my students will just forget about everything, just wait for the last week, rush quickly and read and then come to the test. That's why the ??Salsa?? didn't really fit there. The ??Salsa?? will really fit someone who wants to check his progress, learn and give feedback.*

There is an assumption of this lecturer that the software would fit only the good students who are willing to learn and therefore to use this tool to help them to organize their own learning. It implies that the students who have difficulties with the course may not be happy to use this software. In particular, the motivation to use the software is difficult to achieve with the students who struggle with the course. Regardless of the lack of the motivation on the part of some students, the usefulness of the software for some of the students has been observed by the lecturer as: "And I can see that they carry on doing this because that actually gives them some self-assisting that they are doing right." The lecturer had observed that this software was helping his students to get the feedback from the software about their own learning and success, and therefore students were seeing it as positive, and useful. The major advantage of this feedback was the fact that students did not need to ask the lecturer about their progress, and the lecturer did not need to tell them how they were going, the tool has given them this answer and confirmation of their success. The feedback given to the students by the software was immediate and therefore very effective. It has given the students the feeling of control of their own learning and increased self-esteem. Increased self-esteem in turn causes the belief in one's ability to increase and then one can try taking up more challenging

tasks because they believe that they can do it. The process of self-enforcement of self-efficacy is taking place (Bandura, 1982).

So, in conclusion, the tool was not very helpful to the lecturer and it was not helpful for some of the students. The tool was on the other hand seen as very helpful to the students who used it and were getting regular feedback on how they are going with the course. The usefulness of the tool for these students was confirmed by the lecturer.

## **Lecturer Two**

### **Lecturer usefulness**

This lecturer believed that the software was useful for him, and that he often used the graph that showed his students' progress. The lecturer also used the software to modify his teaching based on the individual needs of the students and the class. The feedback from the students about the course and any problems about teaching, proved to be immediate and effective. It gave the lecturer an opportunity to immediately act upon this student feedback, and to correct and improve any misunderstandings in either teaching material or understanding of the software: "It would appear to be very useful because it gets an immediate response. I think we should take advantage of that. "It gave an opportunity for the lecturer to provide additional support. The lecturer specifically valued this feedback but also mentioned that this in a way increases workload for the lecturers:" I can't say that I'm proud of how immediately I replied. I think that it's a time problem for a lecturer because it increases their workload to some extent even though the information that comes out of it is really useful."

The lecturer is pointing out that that the number of the items in this software (on which students had to make comments, and judgments), is very high. He also said that the questions in the software are not always easy to understand and that these questions should be revised: "I think that its usefulness for students and lecturers is great, but I think the way you put the questions is so critical I'm going to revise the questions."

## **Lecturer two perception of software usefulness for the students**

The usefulness for the students was described by the lecturer as increasing from the beginning of the semester. The students used the software more when they had seen the benefit of its use. The lecturer had mentioned that half of the final mark had been allocated to the students' report. He also mentioned that the usefulness of the software itself was more important to the students than the mark, once students experienced the benefit of using it.

The students obtained another positive outcome from the software use, which was to help them to be more organized. This is particularly important in the first year of the study when students are learning how to study, and how to organize their time during the study.

*And yes, I think that teaching students at the beginning of their courses, where some of them come and are totally disorganised, using ??Salsa?? to help them organise themselves is great. So that's one of the really good potential things that I have seen for many years now, since I first started using it.*

The lecturer firmly believes that students should be in charge of their learning as illustrated by the following statements:

*But I would say that, like me, they [students] are not using it to its full potential. But that's all right – if it's there and they get usefulness out of using it a little bit then it's up to them and they should learn to extend their application.*

The lecturer is clearly seeing the usefulness of the tool for himself and for his students. For the lecturer, the tool is helpful by giving him information on how to improve the course and his teaching. The reports from the software are giving him all this information in a form of students' comments or notifying him that they need help with the particular item. The software is giving him the opportunity to judge which response is more appropriate (class or individual) based on the number of the students asking help for the same item. The students' benefit from the software

was in getting the feedback on their request, immediately, and then being able to use this feedback to improve their own work and their chances to succeed.

### **Lecturer Three**

#### **Lecturer Usefulness**

Another benefit of the use of the software is the ability to identify the need for a course to be fully prepared with all assessment dates before the start of the semester in order to fully utilise the software. The software helps students to be able to see what is in front of them, and as a result better plan for their study. The ETAM model has identified the trends in use of the software as noted by Lecturer Three:

*Right at the beginning though students tended to use it a lot but then I noticed a drop in the number of times they actually accessed the software and it would be that I would have to remind them.*

It has also identified the need for support and guidance for the students to maintain their involvement in the process of monitoring their own learning. It has identified the usefulness for the lecturer to monitor continuously students' involvement and progress outside as well as inside the classroom. The lecturer also raised some concerns in the fact that the course that is completely predefined is not flexible and in her class, she had to change some lectures order and then manage this with the software.

#### **Lecturer three perception of software usefulness for the students**

This model has helped to identify that some students do have a need to ask for help discreetly, and that this was possible by using the software. Lecturer Three noted:

*And there are sometimes students that don't feel very comfortable talking in class about their progress in the course. But yet they were quite comfortable asking for help using the software.*

A special usefulness of the model and software used is in opportunity to intervene when needed because the information is current and it is possible to give immediate feedback. This is illustrated by the example of Lecturer Three writing additional notes for her class when she realised that there was a need for additional explanation evident by large number of the students in the class asking for help. She noted: “ It was more than half the class that said that they needed help on a certain topic. I actually emailed them the extra notes I created directly to the students during the week.” It has modified the lecturer perception of the item difficulty as noted:

*So generally, the theory topics I know are normally a problem I can see on ??Salsa?? Although having said that, there was a practical exercise that I thought most people wouldn't have had a problem with and there were a few that did. So it does give me a way to realise that my perception of what they're going to do is not always on track.*

It has also improved the communication between lecturer and students in a larger class:

*I could even look at what they were doing during class time. I could set them something, like an exercise, then I could go look on ??Salsa?? and see who was having a problem – and then during the lesson just go and talk to those students who were having a problem. So it does give me extra information, if I could say that. This semester was one of the first times that I had a much bigger class than what I usually do and so ??Salsa?? helped me, if I could say, organise it a bit better or maybe just get more feedback from them.*

Of particular importance for students' involvement, according to the lecturer, was the full information about the assessment and all dates and reminders in the software. Students were able to receive a warning that the test is in two weeks' time for example. The students were very happy with this and found it very useful.

The tool seems to be useful for this lecturer and the students in more than one way: it is useful to give feedback to the students, and answer discretely on the

request, to get feedback about the course and how to improve it, to get feedback from the students about the teaching and how to improve it, and to be able to make timely corrections if needed.

#### **Lecturer Four**

##### **Lecturer usefulness**

This lecturer is clearly using a constructivist approach in his teaching. He insisted on his students taking responsibility for their own learning and was able to identify the usefulness of the software for him and his students. For him the student tool was useful for helping students to manage their own learning, and to take ownership, and control of their learning.

*For me the main use is around building a dialogue with the students and trying to build their capability to manage their own learning. So it's trying to shift responsibility away from teaching something ???? so they take ownership of their own learning. So the concept there is that they can become aware not just of what they know but also of how their learning is going week by week – are they on target? Are they achieving their goals?*

The key part of these observations was the fact that teaching was not just a transfer of the facts and information, but was the process in which the lecturer assisted his students to take the ownership of their own success. He encouraged them to actively monitor and manage their own learning and used the software in this way. For the lecturer, the usefulness of the software was in having an excuse (software report) to go and have a conversation with the students.

*Where I would use it is... to produce a printout from each student, sit down with the student and say "You're telling me that you're having difficulties in this area" and start a conversation. I would look at the time they're spending and try and discuss what they have to do to get themselves into a position where they are achieving their goals in the course. So to me, it's kind of an excuse rather than the direct use of the software.*

The lecturer was using this tool as an excuse to start the constructive conversation and discussion with the student, how to put the students in the position where they can achieve their goals, as he is describing it.

#### **Lecturer four perception of software usefulness for the students**

The lecturer also commented on his students' ability to assess their own learning. He stated that he believes that the students are capable of making a judgment about their own knowledge. He expressed the opinion that the hardest thing was: "getting them to accept that it is appropriate for them to judge what they know." The need to develop these skills was clearly expressed as very important. He stated that it does take time for students to engage in self-assessment as it does not happen instantly. The process was that one third of the students are reasonably comfortable and engages immediately, a second third will get there by the end of the course and the last third will say: "What's this got to do with learning?"

This lecturer was seeing the use of the tool as an excuse to start a direct discussion with the students about their own learning and the ways in which they could achieve their goals. He identified that the students benefit from the same conversation was in getting the feedback which helped them to establish how much they know, but also, how much they have to do to achieve their own goals.

In summary, this section presents the analysis of the Perceived Usefulness of the Salsa tool used in managing the learning in the classrooms. The usefulness of the tool has been analysed using the ETAM framework. The analysis included the lecturer perspective of the usefulness for them, and their own perceptions of how their students perceived the usefulness of the same tool. Lecturers expressed the opinion that it was useful with the exception of the Lecturer One. The lecturers' perception of the usefulness of the tool for the students has been expressed as mostly being useful. The richness of the information from the interviews with the lecturers was very valuable and had given the evidence that the ETAM framework is indeed a very effective tool to use in an evaluation of technology acceptance in the educational environment.

### **5.3.2. PERCEIVED EASE OF USE**

As a part of qualitative validation of the ETAM the question about Ease of Use was discussed in the interviews with the lecturers. The Ease of Use is one of two constructs from technology acceptance original model incorporated into the ETAM. This section presents a qualitative analysis of the Ease of Use construct from the four lecturer interviews.

#### **Lecturer One**

##### **Lecturer One Ease of Use**

Lecturer One describes the software as very easy to use and to navigate. He also explained how the same tool can be used on different levels. It can be used at a very simple level for example: “So someone who has no time, he can just click on “Open” and in five minutes you can find all the details you like.” And it can be used at a more sophisticated level as described by the lecturer “Someone who wants to know more – he can go to the graphs, he can go to the statistics, he can do a lot of things. I think, yes, it is very easy to use.” He describes all the menus as very clear to understand and navigate, and self-explanatory. The lecturer did not give any specifics about how he personally had used this tool but the message was clear that in general it was very easy to use. One of the reasons why the tool was so easily adopted by the lecturer may have been the fact that these are the lecturers from the computing degree who are used to continuous introduction of new technologies and tools in their everyday teaching.

##### **Lecturer One perception of students’ ease of use**

The Ease of Use for the students has been described as helpful and easy to use. The lecturer is pointing out that the website would be preferred by the students in his opinion. He admits that he did not compare these two, but believes that the web-based tool would be more accessible for the students. The half an hour session for the introduction of how to use the tool was enough and no student was asking for

additional help. He described that students were capable of using it at any level very easily.

## **Lecturer Two**

### **Lecturer Two Ease of Use**

Lecturer Two described Ease of Use of the tool as being easy and users need little training. He noted that he has not been using the tool to its full potential. He admitted that the tool was very user friendly and he enjoyed using it.

### **Lecturer Two perception of students' Ease of Use**

"I think it's pretty easy for them to use tool actually. But I would say that, like me, they are not using it to its full potential." Lecturer Two described the students' Ease of Use of the tool, as being very simple to use. He has observed that students have not been using the tool to its full potential. He has given an introduction to the use of the tool at the beginning of the second tutorial and has given the students who needed help additional support. He described that his introduction to the use of the tool was just that, the introduction, and he pointed out that it is the students' responsibility to learn how to use more complicated features by themselves. He also explained that the fact that his students were computer students did not necessarily mean an advantage in using the tool because the tool is based on Windows technology which is known by the general public and not just computing professionals.

## **Lecturer Three**

### **Lecturer Three Ease of Use**

"For me to use ??Salsa?? it was quite obviously very user friendly. I enjoyed it. I thought it was really quick to use, you can just tick and mark it as done." This lecturer has used the tool in the class on a regular basis and described its use as friendly and quick to use.

### **Lecturer Three perception of students' Ease of Use**

"I think it was easy for them to use. I never saw anyone that didn't understand what to do." She has described that the majority of the students had used the tool in their learning as a supportive tool to manage their learning but has pointed out that a few students had stopped using it altogether. She has mentioned that two students never used the tool. One has passed and did very well and the other one failed. Her explanation is that the one that passed obviously knew that he was on top of his learning, so did not need any tool to aid this learning.

### **Lecturer Four**

#### **Lecturer Four Ease of Use**

*From a lecturer perspective it is trivial really. Most of the time we'll be going into setting up a detailed course descriptor. Therefore the requirement is really that you have to plan your entire semester at quite a detailed level from Day 1 because the system won't work if you take it week by week. A student must be able to see detailed learning outcomes all the way through the course week by week, what's expected. For me typically, its about two hundred items on a course descriptor. It takes quite a lot of work to get that right.*

Lecturer Four describes that once the preparation of the course was done and the data entered into the software, the use of the tool from the lecturer perspective was really easy. The hard part was in the preparation of the course.

#### **Lecturer Four perception of students' Ease of Use**

*I think from a student point of view, none of them I believe find it difficult to use. It would take two minutes at the front of a session to key in the data. In this we just check off where they are in each item. Having said that of course not all of them will do it. I don't think the reason is that it is hard to use the software. It's perhaps that they don't see the relevance of that to their learning. So there is some work to be done around selling the idea as well as using it.*

The lecturer described the three ways how the students could access the tool: firstly, in the classroom, secondly, from home (the students can install the tool on their computer) and thirdly, from the website. His observation is that the majority of them would use it in the classroom and very few on the internet. He noted that it was easy for the students to use the tool, and the only training they needed was the small introduction to the tool at the beginning of the classes.

In summary, it can be concluded that most of the lecturers who had used the tool had experienced it as easy to use and user friendly. They had reported the difficulties in the use of the tool only at the beginning. The lecturers' perception of how easy the tool was for their students to use is summarized as well as very easy to use. The students needed only the short introduction to the tool at the beginning of the semester in their classrooms.

The main technology acceptance constructs that were covered in the lecturers' interviews (Perceived Usefulness and Perceived Ease of Use) have given a detailed and rich picture of the students' and lecturers' perception of this software technology acceptance. This analysis included both the lecturers' perception of software Ease of Use and the lecturers' perception of their students' Ease of Use of the software, as well as lecturers' perception of Usefulness, and lecturers' perception of Usefulness for their students. The ETAM analytical framework used in this analysis has given rich and valuable information about the technology acceptance of the software used in the classroom. This analytical framework was used as a tool to investigate technology acceptance in an educational environment. It has two major sets of constructs; the technology acceptance constructs from the TAM, and classroom environmental constructs from the WIHIC. This section covered the TAM constructs (Perceived Usefulness and Perceived Ease of Use). Section 5.4 deals with the analysis of the WIHIC constructs.

## 5.4. THE ENVIRONMENTAL CONSTRUCTS ANALYSIS

The ETAM framework has been used in qualitative analysis of the lecturers' interviews. As already presented the interview questions were focused on major technology acceptance constructs and not specifically on the environmental ones. The analysis of the interviews with the ETAM analytical framework, however, showed that in these interviews, the environmental constructs were present and captured, as well as the technology acceptance constructs. Figure 5-4 shows these constructs used in the ETAM framework for the analysis of the four lecturers interviews.

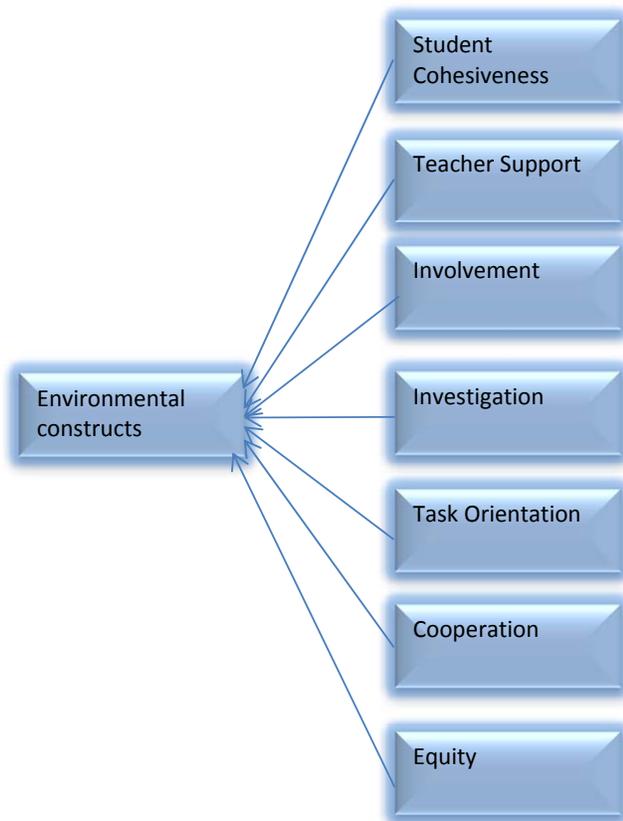


Figure 5-4. Environmental constructs analysis- Lecturer view.

Lecturer One

The environmental constructs that came out in this qualitative analysis of Lecturer One interview were: Task Orientation, Teacher Support, Involvement, Cooperation and some elements of Equity.

The lecturer identified that the students who used the software were also oriented toward the course task. He noted that the ones that were not involved in the class, and not working on their tasks, were not using the software to support their learning.

*I found all the good students filled the ticks, and they don't really need any help- they are happy progressing or checking their progress. While the bad students who I really like to follow up, they weren't really doing that and there is really no way that I can force them to do that.*

Lecturer One also indicated how he was giving support to his students: " I checked it three or four times. I find it easier if I just target the students I feel are weak and sit beside them or answer their questions rather than this indirect way." He preferred to give support and intervene in the process of learning directly with the students, without using the software. As mentioned before some of the reasons for this could be: he may be reluctant to use the software, he may be not quite comfortable with it himself. He has acknowledged that he himself has used it only: "... three or four times..."

#### Involvement and Cooperation

*It might look silly, but I will say it like this. I mean, the program would be very useful if the student would apply it in the right way. But unfortunately, my students didn't and it wasn't really very useful for me. But unfortunately we don't really have those kinds of students whom I consider above average. Our students will wait just a week before the tests. They will just go and sit and read and just go and tick. If you force or ask them to tick they will just tick it randomly without a lot of thought.*

Lecturer One indicated that his students were not involved in the software use adequately and did not have proper use of it. He also indicated that the blame sits

with the students because, his students were not, as he said, the ones that he considers average. The reason why these students did not get involved with the use of the software, and learning with its use is according to the lecturer's judgment, mainly because they seem to be inadequate for the study. He also suggested that getting them involved was not successful because according to him they would not be honest in their answers.

This question on how much students are able to judge their own learning came through strongly in this interview. It seems that the judgment of their abilities has been already made even before they had the chance to become engaged.

According to him all the good students were using the software and successfully checking how they are doing but: "the bad students who I really like to follow up, they weren't really doing that and there is really no way that I can force them to do that." There is a lack of motivation on both sides for the students to use the software because they clearly do not see the benefit of its use and the lecturer also seems to be unconvinced about its benefit.

*But again I have to say that some of them didn't use it. This is again connected to our first part that the weak students who are not really interested in anything, literally they are not interested in assisting themselves. So they won't really come and ask questions because they haven't really used the program.*

Lecturer One also suggested that the cooperation of some students stopped after the first three weeks.

The lecturer has made a strong differentiation between "good" and "bad" students and even though as a lecturer one can understand it, there is still a hint of students not being treated equally as a result of this division.

The result in this case shows that some students lack motivation and enthusiasm, and did not fully participate in the software use as a tool to aid their learning and management process. It also shows that the lecturer did not fully accept the software and did not believe it is useful. There are many reasons for this outcome.

One very important reason is a belief of the lecturer in a meaningful learning that requires appreciation of the value of the students learning in its own right. The lecturer's dismissal of the software benefiting students learning may have resulted in the rejection of some students to use the software. According to the literature (Askar & Umay, 2001; Huang & Liaw, 2005; Teo, 2006) the lecturer's beliefs were transferred to the students, because they themselves did not believe that this software is helpful. Another factor is that the lecturer's view their own role as, being in charge of the transfer of the facts, rather than, as being a coach and guide, and co-learner with the students on their learning journey. And last, but not least, education is and should be about people development, learning how to learn, life-long learning, rather than the transfer of content and facts. All these factors possibly influenced the somewhat disappointing outcome in this case.

#### Lecturer Two

The environmental factors identified in this case during the qualitative analysis were: Task Orientation, Teacher Support, Involvement and Equity. The students' motivation to succeed and Task Orientation has been pointed out by the lecturer who found that students were using the tool more once they realized how useful it is in supporting their own learning. The students would then continue using it for the rest of the semester. Lecturer Two has identified that the participation in the use of the software was slow at the beginning but has grown steadily during the semester. To help new students to be able to better organize themselves for their tasks at the beginning of the program, is viewed by the lecturer, as helpful: "And yes, I think that teaching students at the beginning of their courses, where some of them come and are totally disorganised, using Salsa to help them organise themselves is great.." The lecturer's support of the students during the semester was helped, by using this software. First, it was helpful in identifying a problem with a student, and then applying the appropriate intervention. The intervention may have been given either individually, when only few students asked for help, or for a class, when most of the students asked for help. Lecturer Two has indicated that he has been monitoring students' progress and giving them support all the time during the semester. In particular, Lecturer Two sees the advantage of the tool as a means

of giving immediate responses to the students' queries and suggested that "we should take the advantage of that." The lecturer also seems to be identifying the division between the students at the top of the class: "You never get any trouble with the top of the class." and the students at the bottom of the class: "But some of them have not used it enough to appreciate how useful it can be." suggesting that there is a bit of inequity in his view of the class. Similarly, he is identifying students' involvement as being present, but not an equal involvement for all students. Some of them had a problem with reading all the items and understanding them. The lecturer also commented on students' use of the software as: "not using it to its full potential. But that's all right – if it's there and they get usefulness out of using it a little bit then it's up to them and they should learn to extend their application. "

Lecturer Two is clearly convinced that the tool is useful to him in monitoring students' learning and to students in monitoring they own learning. He sees his students involved in the learning process, and oriented towards the given task. He sees the tool as an aid to their learning journey. He particularly valued the immediate feedback they got from the tool which helped them to persist and overcome the challenges.

Lecturer Three

In the Lecturer Three interview the Teacher Support and Involvement constructs were identified. The lecturer has identified the tool as helpful in giving support to the students in several ways: as a tool to identify the problem, as a tool to interact with the students who prefer more private interaction, and as a tool to identify which feedback is more appropriate, individual or class feedback. In her own words she explained:

*Even though I could listen to students and question and I often had one-on-one time with them in class, it was an opportunity for me to go back to my office and see what they've done in that week. And there are sometimes students that don't feel very comfortable talking in class about their progress in the course. But yet they were quite comfortable asking for help using the*

*software. Within my classes, most students do talk to me and feel quite comfortable. But even if it is one or two students, if its a means for them to get their message across or ask for help I think that's good.*

It helped her to identify the need for additional instructional material to support students' learning, which she produced and distributed to her students. She has constantly used the software in the classroom to aid her immediate support to the class as:

*For me, it was really useful. I could even look at what they were doing during class time. I could set them something, like an exercise, then I could go look on ??Salsa?? and see who was having a problem – and then during the lesson just go and talk to those students who were having a problem. So it does give me extra information, if I could say that.*

The software has helped her in dealing with the larger classes and provided her with information about their progress outside of the classroom:

*This semester was one of the first times that I had a much bigger class than what I usually do and so ??Salsa?? helped me, if I could say, organise it a bit better or maybe just get more feedback from them. When you have smaller classes there is more opportunity to have the one-on-one discussions. Because I had two streams this semester, once you get that it was much more useful to go and read what they had done...say, at night, when I've left the job or something...and then email them later on and say "I've noticed on ??salsa?? that you needed help with this topic" And then I can just explain it on the email.*

Lecturer Three has commented on the students' involvement in the class as being very good at the beginning and then decreasing in the number of times the students actually accessed the software. She has noticed that the students who were motivated used it all the time, and the ones that really were struggling and wanted to do well would use it all the time. For some it was the struggle to keep them motivated to do it.

Lecturer Three has actually used the tool and believes that this tool was useful to her to support her students in their learning journey. Most of her class has been successfully involved using the tool in managing their learning. It is clear that her beliefs and enthusiasm has affected the students' behaviour and attitude towards the tool use, in a positive way.

#### Lecturer Four

In the qualitative analysis of this lecturer interview, Teacher Support and Involvement environmental constructs were identified.

Lecturer Four sees his role as being a coach and co-learner rather than being outside of the learners' group. His approach is to support his students on an individual basis and he used the software reports as an excuse to interact. In his own words:

*So to me the software is about an excuse to have a dialogue with a student of how their learning is going as opposed to just answering technical questions. So that's the driving philosophy. Where I would use it is.... to produce a printout from each student, sit down with the student and say "You're telling me that you're having difficulties in this area" and start a conversation. I would look at the time they're spending and try and discuss what they have to do to get themselves into a position where they are achieving their goals in the course. So to me, it's kind of an excuse rather than the direct use of the software.*

Lecturer Four is shifting the responsibility for learning to the student and he is encouraging them to take ownership of their own learning. In the process, he is making them aware of, not just how they are doing, but also how they can follow this progress continuously week by week. The students were able to make judgments on whether they were on target and how they could achieve their goals. Lecturer Four was encouraging his student to judge their performances and to make their own criteria for such judgment. He was trying to get the learners to set

the criteria for their own success, and what that means to them. A large part of the teacher support of this lecturer is in the reassurance of the students that they will be able to do the task, and succeed. In his own words:

*Therefore a large part of my job is to reassure them and say "You can do this. You are on track. You will get there." So having some separate measure that indicates to them that they are on the target can be very strong. So yes, I believe it is positive overall for the students.*

The lecturer noted that not all students would get on board with this idea, and expressed his opinion that it is appropriate to be involved in your own learning, and this skill should be built over a longer period of the time, and through many courses.

Student involvement was dependent on students' acceptance that it is appropriate for them to judge what they know.

*So the idea that they should develop their own ideas about what is good or bad is quite alien to them. In that context, we don't expect instantly all students to engage with that idea. I would say a third of the class would be reasonably comfortable with that quite quickly, a third would get there by the end of the course and a third would say "What's this got to do with learning?"*

The lecturer explained that some of the students, who engaged with the tool, really enjoyed it and were able to go ahead. They were able to see the whole course, what is needed and when, and monitor that they are on track to succeed. Lecturer Four emphasised the importance of reading the reports and acting upon any request instantly. He also highlighted the importance of the tool in the role of supporting and aiding the learning of the first semester students. In particular, he stressed the role of the tool in assisting mature students in their queries, allowing them to send their requests privately and get the response privately as well. This is particularly important in some cultures (such as Chinese) because it prevents students from losing face. So for the mature student it is much easier to tick the box and have a private channel to ask the question, and get the answer from the

lecturer. Without this private way of asking some may feel that all younger students do understand it all and it is just them that do not and therefore they disengage. The last comment that Lecturer Four made is the following:

*Having said that of course not all of them will do it [use the software]. I don't [think] the reason is that it is hard to use the software. It's perhaps that they don't see the relevance of that to their learning. So there is some work to be done around selling the idea as well as using it.*

The question: how to make students aware that the learning is more important than the content of the course is certainly a challenge, in every course taught by the constructivist lecturer. This is getting even harder if the constructivist lecturers are a minority in the school and their beliefs and methods are not understood, or supported by the management. This lecturer is using the tool in a way that gives the full benefit for learning and teaching in his class. The tool represents, for him, an aid to his constructivist approach to teaching.

The ETAM analytical framework used in this qualitative analysis has uncovered so much more than just attitudes toward technology acceptance. It has provided rich information about the perceptions of the educational environment and about the learning and teaching that has taken place in these classes. It has identified the attitude towards Usefulness and Ease of Use of the software from the lecturers' point of view. It has uncovered the lecturers' perception of tool Usefulness and Ease of Use for their students. It also has given me a rich description of the dynamics of the classes, the students' and the lecturers' views. It has revealed the lecturers' perceptions of some of the environmental factors such as: Teacher Support, Involvement, Task Orientation and Equity. The next section describes the demographics elements identified with the use of ETAM framework in the qualitative analysis.

## 5.5. DEMOGRAPHICS

Demographics used in the ETAM analytical tool were: Gender, Age, Experience, and English Language. This qualitative analysis has found some statements in the interviews of two lecturers that may illustrate the feelings and emotions of the students for whom English language is not their first language. The comments made by Lecturer Three and Lecturer Four in their interviews illustrate this. Lecturer Three commented on how she was coping with the large class and how the size of the class has affected the communication between lecturer and students.

*Whereas I find that if there wasn't ??Salsa?? and I wasn't using this semester and I didn't have the chance to talk to everybody in my class, the only way they would get to ask me for help is to email me and again, not all students like doing that. They might not like sitting down to write an email, or they might feel a bit embarrassed. Whereas it seems like they can just tick "I need help with this" on ??Salsa??. It's not as much effort. So that was really, really helpful.*

Her comments may be interpreted in two ways; either students did not have a time to communicate with her, because of the large size of the class, or because they are not comfortable asking questions in front of all the class. The reason may be that their language command was not good enough and they did not want to be embarrassed. In any case the software was helpful in addressing this problem. The ETAM framework analysis has identified these indications about students' feelings as observed by the lecturer.

Lecturer Four was very specific in pointing out the benefit of the software in helping the students from other cultures to feel comfortable asking questions. They were able to use the software to do it. In his own words he stated:

*But for some of our students, particularly mature students, they may be reluctant to hold their hand up in class and admit that they need help, particularly in the Chinese community. It can be a loss of face, a feeling that all the young people around them understand it and they don't. The real danger*

*is that they may just disengage. So having a private channel by which they can communicate difficulties.....it's much easier to tick a box on a computer form than to stand up in front of other people. So I think, not obviously for the majority of the class, but for some people it can be quite good.*

There may be two reasons for the reluctance of students to ask questions in the class. The first one is loss of face (particularly in the Chinese culture), and the second one is being uncomfortable with their knowledge of the English language. In any case, the software seems to be helping according to both lecturers and the ETAM framework has revealed this information about students' feelings and possible reluctance to ask questions openly in the classroom.

The English language was the only demographics construct identified in the lecturers' interviews.

## **5.6. DISCUSSION**

The ETAM analytical framework has been used in the qualitative analysis of the lecturers' interviews. The interviews were structured around two main topics: Perceived Usefulness and Perceived Ease of Use. The analysis has shown that this analytical framework worked really well. It has identified the main elements of technology acceptance constructs as well as environmental ones. In addition one demographic construct, English language proficiency, has been identified within this analysis.

The ETAM framework has been very useful in providing the analytical structure for the qualitative analysis of the lecturers' interviews. It has also helped in identifying the key elements of the process during the lecturer interviews analysis. It has identified not only the elements of the topics that were introduced, but also, some of the environmental constructs of this framework had surfaced on their own, within the interviews, showing that there is a natural connection between technology acceptance constructs and educational environmental constructs. These educational constructs were not specifically asked about during the interviews. As

discussed previously, the interviews focused on only two major topics (Perceived Usefulness and Perceived Ease of Use). The interview could not introduce all the elements of the ETAM framework because that would jeopardise the quality of the answers. The increased number of the topics would decrease the quality of the answers. It is recommended that interviews should be focused on four to five questions in order to get the maximum richness and the feelings from the qualitative answers.

On reflection it is fair to say that the ETAM framework has been very easy to use in identifying the perceptions of the usefulness of the software for the lecturer, and in identifying the lecturers' perceptions of their students' views on the usefulness of the software used in the class.

By the same logic it is also fair to say that the ETAM framework was very easy to use in identifying the perceptions of the Ease of Use of the software for the lecturer, and in identifying the lecturers' perceptions of their students' Ease of Use of the same software used in the class.

This framework has been very useful by giving the researcher a structured way of conducting a qualitative analysis of all the interviews.

The perceived usefulness of the ETAM tool as an analytical framework comes from the usefulness of the software tool that has been investigated. So because the ETAM is an educational tool, my evaluation is using it as a framework to identify the usefulness of the software Salsa and at the same time by doing this, evaluating this framework as an educational technology acceptance tool.

The ETAM framework has been very easy to use in this qualitative analysis of the lecturers' interviews, as well as being a useful analytical framework.

The ETAM analytical framework has given rich and valuable information for the evaluation of the acceptance of the software used in the classroom. This framework is proposed as a tool that can investigate technology acceptance for a specific educational environment. It has two major sets of constructs; the technology acceptance constructs from the TAM, and classroom environmental constructs

from the WIHIC. In addition it has the following demographics elements: age, gender, prior experience and English as a first language. The main technology acceptance constructs that were discussed in the lecturers' interviews (Perceived Usefulness and Perceived Ease of Use) have given a detailed and rich picture of the students' and lecturers' perception of the technology acceptance of the Salsa software used in the classroom. It includes both the lecturers' perception of usefulness, and the lecturer's perception of usefulness for their students, and also the lecturers' ease of use, together with the lecturers' perception of their students' ease of use of the tool.

Table 5.1 presents the main findings of the qualitative analysis of the lecturers' interviews using the ETAM analytical framework. The rows in the table represent the technology acceptance constructs and educational environmental constructs. In addition, the main findings of the demographic element are presented. The columns in the table represent the lecturers (one to four) interviewed in this research.

Table 5.1.

*Summary of the Qualitative Analysis Using the ETAM as Analytical Framework*

ETAM tool	Lecturer one	Lecturer two	Lecturer three	Lecturer four
<b><i>Technology Acceptance Constructs</i></b>				
<b><i>Lecturers' Perceived Usefulness</i></b>	It was not useful, but useful to diagnose students with the problems	Useful to monitor students' progress, Feedback on the course and teaching, opportunity to make immediate corrections	Continuous monitoring of students' progress in and out of the classroom allow for fast intervention, helps manage large classes	The report from the tool used as an excuse to start constructive dialogue with the student, developing the professional judgment skill, self-assessment skill

<b><i>Perceived Usefulness for students</i></b>	Useful to get the immediate feedback about their work	Useful, immediate feedback, helping to manage and organize the study, to take ownership of the learning	Able to ask for help discreetly allow for the fast feedback and intervention, better and faster communication with the lecturer, warning for the assessment dates	Helping to manage their own learning, be aware of the content as well as the progress on their own learning and active monitoring of learning, to be able to achieve their goals,
<b><i>Lecturer's Perceived Ease of Use</i></b>	Easy to navigate, simple to use, very easy to use, clear menus ease to understand	Easy to use, very little training needed, very user friendly, enjoyable	Obviously very user friendly, quick to use, used it regularly	It was trivial to use, the most difficult part is preparation of the course descriptor and material for use, very easy to use
<b><i>Perceived Ease of Use for students</i></b>	Easy to use, website may be preferred, no student asked for additional help	Very easy to use, introduction given and some additional help,	Easy to use, students were using it with ease	No difficulty in the use for students, brief introduction at the beginning was enough

***Environmental constructs***

<b><i>Student Cohesiveness Teacher Support</i></b>	I checked it two to three times but it was easier to talk to the students directly	Tool has helped in identifying the problem, in monitoring the students' progress, giving the immediate response	Tool aided the lecturer in supporting students in identifying the problem, to interact better with the students who prefer private interaction, identified need for additional instructions, interacting with the large class better	The software initiated the dialog with the student to identify the problem and discuss the solution, students are taking the ownership of their own learning, they feel in charge, they monitor their learning, it reassures student that they are on the track
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<b><i>Involvement</i></b>	Students did not apply software in a right way, our students are not above average bad students did not used it at all and I cannot force them to use it	Students were involved in the class but not equally, they did not use the tool to its full potential	Very good involvement in the class at the beginning and then drop in numbers motivated students used it all the time, and students who would like to improve the results used it all the time	Not all students were involved, but when they started and got the feedback they would use it, it allowed other cultures to save face by asking questions privately (Chinese) particularly for mature students
<b><i>Investigation</i></b>				
<b><i>Task Orientation</i></b>	Good students were working on the tasks but the bad one did not	Student were motivated to succeed and used the tool when they realise how useful it was to organize their learning and give them the feedback how they progress		
<b><i>Cooperation Equity</i></b>		Student divided into the top of the class and the bottom of the class		
<b><i>Demographics</i></b>				
<b><i>Gender</i></b>				
<b><i>Age</i></b>				
<b><i>Experience</i></b>				
<b><i>English Language</i></b>			The students may not like to ask questions in the class, software has given the opportunity to interact with the lecturer privately.	Chinese students were reluctant to ask in the class because of fear from loss of face.

## 5.7. CHAPTER SUMMARY

This Chapter presents the qualitative analysis of the lecturers' perceptions of technology acceptance in an educational environment. It relates to the following objective of the study from the lecturer perspective:

- To evaluate the effectiveness of the ETAM model from students' and lecturers' perspectives.

The four lecturers' interviews were analysed. The ETAM framework was used as a framework for this qualitative analysis. The framework has three parts: technology acceptance constructs, educational environment constructs and demographics. The findings of the qualitative analysis have been structured according to the ETAM framework and presented in Table 5.1. The results showed that the framework was easy to use, to investigate both usefulness of the software used, and ease of use for the same software. It has investigated the lecturers' perceptions of usefulness and ease of use of the software, and the lecturers' perceptions of students' usefulness and ease of use of the software.

The ETAM framework has proved to be easy to use in identifying the Usefulness and Ease of Use of the software for the lecturer, and in identifying the lecturers' perceptions of the Usefulness of the software for the students in their classes. The ETAM framework has identified not only the technology acceptance constructs (Perceived Usefulness and Perceived Ease of Use), but also the constructs from educational environment part of the framework. Despite the fact that these constructs were not specifically asked about in the interviews, they did surface on their own within this framework, showing that this was a natural composition of the constructs for this framework, and an appropriate one to use. The presence of both the technology acceptance constructs and the educational environment constructs in the interviews gave some indications that these two parts do fit well together. The fact that both of these instruments (the TAM and the WIHIC) do fit together and they delivered rich pictures of the technology acceptance in the educational environment reflects also on the use of ETAM as a framework for this analysis. This evaluates the ETAM as a useful and easy to use framework for the research investigations into technology acceptance in classrooms.

This chapter presented the qualitative analysis of the lecturers' interviews undertaken with the ETAM analytical framework. It has included an analysis of technology acceptance constructs, educational environment constructs and

demographics. The ETAM framework has been used as an analytical framework for the technology acceptance constructs Ease of Use and Usefulness, and educational environmental constructs from the WIHIC. The WIHIC constructs identified by the ETAM analysis included: Task Orientation, Teacher Support, Involvement, and Equity.

The student perspective of technology acceptance in the educational environment is presented in Chapter 6.

## Chapter 6.

### STUDENT PERSPECTIVE

#### 6.1. INTRODUCTION

In Chapter 4, the concept of the educational technology acceptance model, ETAM, was described. The chapter also presented the hypotheses of this thesis and described the methodologies by which these hypotheses will be tested. This chapter describes the testing of hypotheses related to students' perception of the ETAM instrument. The student perceptions of the technology in an educational classroom environment were assessed with a questionnaire. Thus, testing of the hypotheses has been undertaken by using quantitative methodology. The hypotheses tested were as follows:

- H1a Task Orientation will be positively associated with Perceived Usefulness*
- H1b Teacher Support will be positively associated with Perceived Usefulness*
- H1c Investigation will be positively associated with Perceived Usefulness*
- H1d Involvement will be positively associated with Perceived Usefulness*
- H1e Equity will be positively associated with Perceived Usefulness*
- H1f Cooperation will be positively associated with Perceived Usefulness*
- H1g Student Cohesiveness will be positively associated with Perceived Usefulness*
- H2a Task Orientation will be positively associated with Perceived Ease of Use*
- H2b Teacher Support will be positively associated with Perceived Ease of Use*
- H2c Investigation will be positively associated with Perceived Ease of Use*
- H2d Involvement will be positively associated with Perceived Ease of Use*
- H2e Equity will be positively associated with Perceived Ease of Use*
- H2f Cooperation will be positively associated with Perceived Ease of Use*
- H2g Student Cohesiveness will be positively associated with Perceived Ease of Use*
- H3 Male perception of Perceived Usefulness will be more positive than females.*
- H4 Female perception of Ease of Use will be more positive than males.*
- H5 Older students will have more positive perceptions of Perceived Usefulness*

*than younger students.*

- H6 Older students will have more positive perceptions of Perceived Ease of Use than younger students*
- H7 Students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience.*
- H8 Students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience*
- H9 Students with English as a first language will have a more positive perception of perceived ease of use than students with another first language.*
- H10 Students with a non-English speaking background are likely to have higher perceptions of Perceived Usefulness than English speaking background students.*

The structure of this chapter is organised in the following manner. It begins with an introduction and is followed by section 6.2 which explains the research methodology. Section 6.3 describes the instrument and section 6.4 describes the sample. This is followed by screening of data in section 6.5 and the results in section 6.6. The results are discussed in section 6.7 and the chapter finishes with a conclusion in section 6.8.

## **6.2. METHOD**

To gather student perceptions, a purpose-written questionnaire was developed. This was tailored to the Salsa software used. The questions were organised into two scales, corresponding to the Perceived Usefulness and Perceived Ease of Use constructs from the TAM, and to the seven subscales from WIHIC: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness. Students in classes where the Salsa software was used, the course lecturer had given consent, and there was no teaching relationship between the researcher and the students, were invited to participate in the study. Their

participation was voluntary. A participant information sheet was given to all invited students. Students who chose to participate were given the paper questionnaire to complete. The questionnaire was anonymous. The questionnaire was administered and collected by the researcher in the invited classes, independently of the lecturers. The data collected by the questionnaire were entered into a computer program by the researcher, for analysis.

The broad approach to testing these hypotheses is correlational and first order correlations were investigated. To determine the unique contributions of each component, path analysis and multiple regressions were used. The path analysis used the model was presented in Figure 4-3 and Figure 4-4. ANOVA was used to explore the effect of categorical variables such as gender and experience.

### **6.3. THE INSTRUMENT**

The instrument used in this study, to capture the student perspective, was combined from two sources. The first source was the original technology acceptance model (TAM) of Davis (1986) with two basic constructs, Perceived Usefulness (PU) and Perceived Ease of Use (PEU). The second source was the WIHIC (What Is Happening In this Classroom) instrument (Fraser, Fisher, & McRobbie, 1996). The constructs from these two sources were then combined with four demographic elements to make up the ETAM. This model was translated into the appropriate scales (and items) and then constructed into the questionnaire. This questionnaire was then administered to the students in this study. It is noteworthy that WIHIC instrument was chosen because it was the most comprehensive and widely-used instrument for investigation of student perceptions of educational environments.

The TAM scales

The items of Perceived Usefulness scale were based on students' experience with the software use and required students to indicate how useful they found the features of the Salsa software to be. For example, a typical item of the Perceived

Ease of Use scale would be to indicate how easy or difficult they found the following item: "Learning to use the software". The answers were measured on a scale of: Very difficult, Difficult, OK, Easy and Very easy. A typical item in the Perceived Usefulness scale would be to indicate how useful the students have found: "The graph showing your learning progress". The answers were measured on scale from: Not useful at all, Little use, Some use, Fairly useful and Very useful.

#### The WIHIC scales

The WIHIC scales: Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness were included in the questionnaire.

A representative item of the Student Cohesiveness scale is "I make friends among students in this class", the Teacher Support scale "The teacher takes a personal interest in me", the Investigation scale "I am asked to think about the evidence for my statements", the Involvement scale "I discuss ideas in this class", the Task Orientation scale "I know the goals for this class", the Cooperation scale "I work with other students on projects in this class", and Equity scale "I am treated the same as other students in this class" (Fraser, Fisher, & McRobbie, 1996). All the responses to all the items on these scales were measured on a five point scale: Never or Almost never, Rarely, Sometimes, Often, and Almost always. The complete questionnaire for this study is presented in Appendix A of this thesis.

#### The demographic investigations

The demographics comprised four questions. The questions were about age, gender, English language, semester of study and prior experience. The question about age was: "Your age on your last birthday?" The answers were measured on the four point scale: under 21, 21-25, 26-30, over 30. The question about English language proficiency was: "Is English your first language?" and answers were measured on two point scale: Yes or No. Similarly the gender question was measured on two point scale as well: Male or Female. The question about the semester of the study was: "Is this your first semester here?" The answers were measured on two point scale: Yes or No. The last demographic question covered

prior experience of the students with the question: “How did you spend most of your time in the six months prior to starting this course?” The answers were measured by three point scale: working, studying and other.

#### 6.4. THE SAMPLE

The student sample was comprised of students from courses using the Salsa software who chose to participate. The questionnaire was administered to students in five classes over two semesters. The classes were computer science, information technology, multimedia and business computing disciplines. In total, ten classes of students participated over two semesters; five classes in the first semester and five classes in the second semester. From these classes 218 student responses were collected. Table 6.1 presents the students sample from these ten classes together with the results of the demographic questions.

Table 6.1.

*Student Sample*

<b><i>Student Sample</i></b>	<b><i>Description</i></b>	<b><i>Number of Students</i></b>
<b>Age</b>	Under 21	104
	21-25	53
	26-30	15
	Over 30	36
<b>Gender</b>	Male	130
	Female	79
<b>Semester of study</b>	Yes, it is first semester	74
	No, it is not	135
<b>English language</b>	English is the first language	101
	No it is not	109
<b>Prior experience</b>	Working	49
	Studying	116
	Other	31
	Working/Studying	12

Out of 218 students from ten classes half of them were under 21 years of age. The above age 21 is comprised of 53 students between 21 to 25, and 15 students from

26 to 30. Only 36 students were above 30 years of age. The sample had 130 males and 79 females. Students were also asked whether or not the semester they were in at the time of the data collection, was in fact their first semester of the study. The outcome was that 74 students of this sample were in the first semester of their study and 135 students were not. Out of 218 students 101 declared to have English as their first language, and 109 declared that they did not have English language as their first language. The prior experience showed that 49 students were working prior to the study, and 116 students were studying prior to the semester of the data collection. 31 students declared that they undertook other activities, and the remaining 12 students did both, study and work.

## 6.5. SCREENING

The main summary statistics are shown in Table 6.2.

Table 6.2.

### *Summary Statistics*

Measure		Alpha	PSR	Strata	ISR	Strata	N	COR	Fit
PU	Perceived Usefulness	0.966	0.950	6.2	0.988	12.6	194	89%	yes
PEU	Perceived Ease of Use	0.941	0.918	4.8	0.989	13.2	193	90%	yes
W01	Cohesiveness	0.855	0.853	3.6	0.986	11.5	199	89%	yes
W02	Teacher Support	0.918	0.899	4.3	0.991	14.1	192	90%	yes
W03	Involvement	0.907	0.907	4.5	0.993	16.1	200	89%	yes
W04	Investigation	0.916	0.917	4.8	0.993	16.6	195	90%	yes
W05	Task Orientation	0.889	0.865	3.7	0.983	10.4	187	90%	yes
W06	Cooperation	0.905	0.897	4.3	0.991	14.1	192	90%	yes
W07	Equity	0.934	0.889	4.1	0.984	10.9	157	91%	yes

In this table, the alpha column shows Cronbach's alpha for the respective scale; PSR shows the Rasch Person Separation Reliability for the scale, followed by the equivalent number of statistically distinct strata; ISR shows the Rasch Item Separation Reliability, followed by the number of strata; N shows the effective sample size; COR shows Guttman's coefficient of reproducibility; the fit column indicates whether this reproducibility is within 95% confidence limits.

Cronbach's alpha (Cronbach, 1951) is a measure of the internal consistency of a scale that is calculated in the observed score metric. The Person Separation Reliability (Wright & Stone, 1999) is an equivalent measure calculated in a linear metric. Both of these indicators measure how well the items in the scale separate people; the associated strata shows the number of statistically distinct strata (Wright & Masters, 1982) that can be identified by the achieved separation reliability. In contrast, the Item Separation Reliability (Wright & Stone, 1999) measures how well the people in the sample separate the items. Since not all respondents answered all questions, the effective sample size shown is less than the overall sample size. The coefficient of reproducibility (Guttman, 1944) measures how well each respondent's individual responses can be reproduced from the imputed scale locations.

All person separation reliabilities are above 0.8, and the corresponding numbers of statistically distinct strata are all above 3. These figures suggest that the number of items in each scale is adequate for basic person separation. All item separation reliabilities are above 0.98, and the corresponding numbers of statistically distinct strata are above 10. These figures suggest that the sample size is adequate for clear item separation. For each scale, the level of reproducibility is around 90%, and within expected limits. This suggests that a linear model adequately captures the variability in the sample.

### **6.5.1. MEASUREMENT HYPOTHESES**

According to Lopez (2012), 13 measurement hypotheses need to be established for valid construction of measurement from ordinal data:

- MH1: that the underlying construct is quantifiable
- MH2: that the response categories are ordinal
- MH3: that the construct is unidimensional across both subject and items
- MH4: that there is no differential item functioning
- MH5: that there is no subject response set

- MH6: that there is no local dependence among subjects or items
- MH7: that the measurement model converges correctly
- MH8: that there are adequate data to establish measurement
- MH9: that all measurements can be placed on a common metric
- MH10: that response patterns are reproducible from measurements
- MH11: that there are no more outliers than expected
- MH12: that model fit statistics accord with expectations
- MH13: that there is adequate reliability for useful measurement

The results of these hypothesis tests are shown in Table 6.3.

Table 6.3.

*Measurement Hypothesis Tests*

Measure	MH1	MH2	MH3	MH4	MH5	MH6	MH7	MH8	MH9	MH10	MH11	MH12	MH13
PU Perceived usefulness	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
PEU Perceived ease of use	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W01 Cohesiveness	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W02 Teacher support	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	✓	✓
W03 Involvement	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W04 Investigation	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W05 Task orientation	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W06 Cooperation	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓
W07 Equity	✓	✓	✓	x	✓	x	✓	✓	✓	✓	✓	x	✓

From this table, it can be seen that the data conform to all measurement hypotheses except three: MH4, MH6, and MH12. MH4 tests for differential item functioning. *Differential Item Functioning* (DIF) occurs when an item is more difficult to endorse for one group of subjects than another and this difference is not attributable to the underlying attitudes of the members of the groups (Zumbo, 1999). DIF can be detected by examining differential responses to an item by groups of subjects, while conditioning on the imputed underlying attitude. MH6 tests for local independence. With local independence, responses by a subject to an

item should not be influenced by the subject's response to any other item. Also, responses to an item by a subject should not be influenced by any other subject's response to that item. MH12 tests that the model fit statistics accord with expectations. Two tests of fit were carried out. The first test used the procedure set out by Wright and Stone (1999). The second test was a standard  $\chi^2$  goodness of fit test of observations against model expectations.

None of these hypothesis test failures was critical because the software used was able to make the necessary corrections to compensate for the failures. However, the existence of DIF is interesting in its own right and is explored further in the following section.

### 6.5.2. DIFFERENTIAL ITEM FUNCTIONING BY GENDER

Of the 218 students participating in the study, 79 were female, 130 were male, and 9 did not disclose their gender. Differential item functioning was diagnosed on four questions of three scales (see Table 6.4).

Table 6.4.

*Differential Item Functioning by Gender*

Scale	Question	Effect size	Relative difficulty of endorsement by gender
<b>W01</b>	<b><i>Cohesiveness</i></b>		
	C08 In this class, I get help from other students	2.1%	+ .24 (Male) - .36 (Female)
<b>W03</b>	<b><i>Involvement</i></b>		
	C20 My ideas and suggestions are used during classroom discussions	6.0%	+ .53 (Female) - .32 (Male)
	C23 Students discuss with me how to go about solving problems	5.4%	+ .27 (Male) - .51 (Female)
<b>W05</b>	<b><i>Task Orientation</i></b>		
	C40 I know how much work I have to do	4.1%	+ .32 (Male) - .46 (Female)

+ more difficult to endorse, - less difficult to endorse

In this table, only significant effects (at  $p < .05$ ) are shown. Although statistically significant, the effect sizes were relatively modest: all were less than 10%. After

controlling for other indicators of cohesiveness, males found it harder than females to endorse the statement that they got help from other students. After controlling for other indicators of involvement, females found it harder than males to endorse the statement that their ideas and suggestions were used during classroom discussions, but found it easier than males to endorse the statement that students discussed with them how to go about solving problems. After controlling for other indicators of task orientation, males found it harder than females to endorse the statement that they knew how much work they had to do.

### 6.5.3. DIFFERENTIAL ITEM FUNCTIONING BY WHETHER FIRST SEMESTER OF STUDY OR NOT

Of the 218 students participating in the study, 74 were in their first semester of study at the institution, 135 had been studying with the institution for a longer time, and 9 did not answer the question. Differential item functioning was diagnosed on six questions of two scales (Table 6.5).

Table 6.5.

#### *Differential Item Functioning by Whether First Semester of Study or Not*

Scale	Question	Effect size	Relative difficulty of endorsement by group
<b>PU</b>	<b><i>Perceived Usefulness</i></b>		
A12	Seeing the current status you have recorded for learning outcomes	3.3%	+ .07(not first semester) -.31 (first semester)
<b>W07</b>	<b><i>Equity</i></b>		
C50	I get the same amount of help from the teacher as do other students	6.2%	+ .85 (first semester) -.18 (not first semester)
C51	I have the same amount of say in the class as other students do	2.6%	+ .55 (first semester) -.27 (not first semester)
C52	I am treated the same as other students in the class	2.7%	+ .21( not first semester) -.30 (first semester)
C54	I get the same opportunity to contribute to class discussions as other students	3.1%	+ .19 (not first semester) -.48 (first semester)
C56	I get the same opportunity to answer questions as other students	3.3%	+ .18 (not first semester) -.51 (first semester)

In this table, only significant effects (at  $p < .05$ ) are shown. Although statistically significant, the effect sizes were relatively modest: all were less than 10%. Students in their first semester of study found it easier to endorse the Usefulness of seeing the current status recorded for learning outcomes, after controlling for other indicators of usefulness. After controlling for other measures of equity, students in their first semester of study found it easier than others to endorse the beliefs that they were treated the same as others and had the same opportunity to answer questions and contribute to discussions. However, they found it harder to endorse the idea that they got the same amount of teacher support, or say in the class, as other students.

#### 6.5.4. DIFFERENTIAL ITEM FUNCTIONING BY FIRST LANGUAGE

Of the 218 students participating in the study, 101 said English was their first language, 109 said it was not, and 8 did not disclose whether it was their first language. Differential item functioning was diagnosed on 13 questions of seven scales (see Table 6.6).

Table 6.6.

##### *Differential Item Functioning by First Language*

Scale	Question	Effect size	Relative difficulty of endorsement by first language
<b>PU</b>	<b><i>Perceived Usefulness</i></b>		
A04	Seeing progress bars of your learning progress	2.7%	+ .22 (English) -.23 (Not English)
A05	Showing success and excellence regions on the learning progress graph	3.0%	+ .07 (English) -.13 (Not English)
<b>W01</b>	<b><i>Cohesiveness</i></b>		
C01	I make friends among students in this class	5.6%	+ .12 (Not English) -.20 (English)
C02	I know other students in this class	2.1%	+ .18 (Not English) -.30 (English)
C08	In this class, I get help from other students	3.0%	+ .41 (English) -.40 (Not English)
<b>W02</b>	<b><i>Teacher Support</i></b>		
C15	The teacher moves about the class to talk with me	5.0%	+ .36 (Not English) -.44 (English)
C16	The teacher's questions help me	2.8%	+ .32 (English)



Orientation, those whose first language was not English found it relatively easier to endorse the statement that they knew how much work they had to do. Finally, after controlling for other indicators of Cooperation, those whose first language was not English found it relatively easier to endorse the statement that other students worked with them to achieve class goals.

### 6.5.5. DIFFERENTIAL ITEM FUNCTIONING BY PRIOR EXPERIENCE

How did you spend most of your time in the six months prior to starting this course? Of the 218 participants, 208 answered this question. The distribution of responses is shown in Figure 6-1. In this figure W-represents working, S-represent studying, O-represents others, and WS-represents working and studying. Differential item function was diagnosed in three questions of two scales (see Table 6.7).

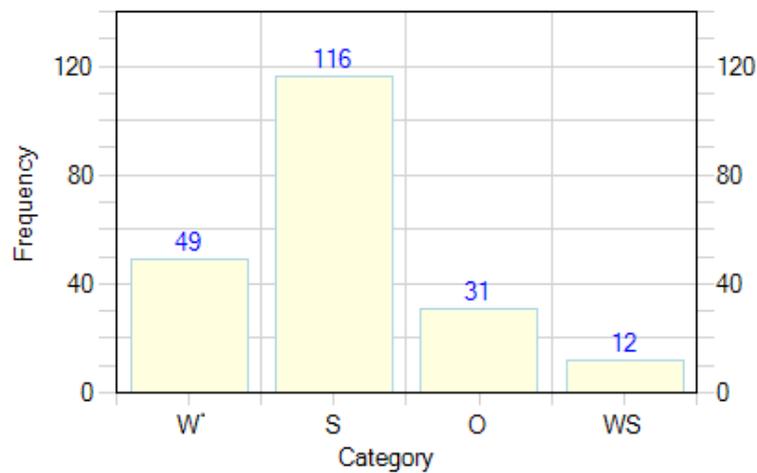


Figure 6-1. Distribution of responses by prior experience.

Table 6.7.

*Differential Item Functioning by Prior Experience*

Scale	Question	Effect size	Relative difficulty of endorsement by group
<b>PEU</b>	<b><i>Perceived Ease of Use</i></b>		
	B03 Learning to enter the weekly reports	7.0%	+0.86 (Working and studying), +0.08 (Studying)
			-0.74 (Working)
	B10 Learning how to interpret the graphs		+0.66 (Working)
			-0.41 (Studying)
<b>W05</b>	<b><i>Task Orientation</i></b>		
	C36 I am ready to start class on time		+0.93 (Working and studying), +0.19 (Working)
			-0.76 (Other)

In this table, only significant effects (at  $p < .05$ ) are shown. Although statistically significant, the effect sizes were relatively modest: all were less than 10%. After controlling for other indicators of Perceived Ease of Use, students who were working and studying, or studying only, found it harder to endorse the statement about learning to enter the weekly reports than students who were working only. The students who were working also found it harder to endorse the statement of learning how to interpret the graphs than did the students who were studying. After controlling for other indicators of Task Orientation, students who were working and studying, and working only, found harder to endorse the statement that they are ready to start class on time than other students.

### 6.5.6. DIFFERENTIAL ITEM FUNCTIONING BY CONSENT

All students whose responses are analysed gave consent for their questionnaire responses to be used for research. This question relates to an additional question as to whether or not they have given consent for their software reports data to be accessed and used in the research, and whether or not they have given the permission to access their final marks for the course. These software report data and final marks data were not used in this thesis.

The consent question was answered by 147 respondents; 71 did not answer this question. Of the 147 respondents, 53 gave consent, and 94 did not.

Differential item functioning was diagnosed in four questions from four scales (see Table 6.8).

Table 6.8.

*Differential Item Functioning by Consent*

Scale	Question	Effect size	Relative difficulty of endorsement by group
<b>PU</b>	<b><i>Perceived Usefulness</i></b>		
	A10 Seeing a checklist of the expected learning outcomes	5.2%	+.30 (No consent)
			-.62 (Consent)
<b>W01</b>	<b><i>Cohesiveness</i></b>		
	C03 I am friendly to members of this class	2.9%	+.32 (No consent)
			-.28 (Consent)
<b>W03</b>	<b><i>Involvement</i></b>		
	C24 I am asked to explain how I solve problems	3.2%	+.63 (Consent)
			-.12 (No consent)
<b>W06</b>	<b><i>Cooperation</i></b>		
	C45 I learn from other students in this class	3.6%	+.38 (No consent)
			-.31 (Consent)

As usual, only significant effects (at  $p < .05$ ) are shown. Although statistically significant, the effect sizes were relatively modest: all were less than 10%. After controlling for other indicators of Perceived Usefulness, students who have given no consent found it harder to endorse the statement of seeing the checklist of the expected learning outcome than students giving consent. After controlling for Cohesiveness students who have given no consent found it harder to endorse the statement of I am friendly to members of this class, than students giving consent. After controlling for Involvement students who have given consent found it harder to endorse the statement of being asked to explain how they solve problems, than students who did not give consent. After controlling for Cooperation students who have given no consent found it harder to endorse the statement of learning from other students in this class, than students who gave consent.

### 6.5.7. DIFFERENTIAL ITEM FUNCTIONING BY AGE GROUP

Of the 218 students participating in the study, 10 did not disclose their age group. The distribution of the remaining 208 students is shown in Figure 6-2.

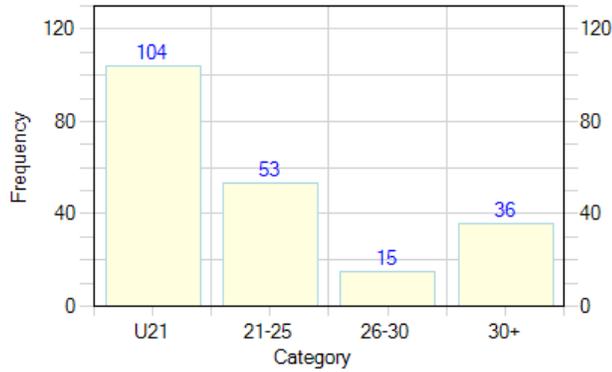


Figure 6-2. Distribution of participants' ages.

Differential item functioning was diagnosed on ten questions of six scales (see Table 6.9).

Table 6.9.

#### Differential Item Functioning by Age

Scale	Question	Effect size	Relative difficulty in logits of endorsement by age group
<b>PU</b>	<b>Perceived Usefulness</b>		
	A01 The graph (time) showing the time spent	7.1%	+ .71 (30+) -0.05 (U21), -.41 (26-30)
	A16 Being able to have exclusive one-to-one time discussing learning with the tutor	5.8%	+ .28 (26-30) -.17 (U21)
<b>PEU</b>	<b>Perceived Ease of Use</b>		
	B06 Understanding the graph	5.3%	+ .59 (21-25) -.25 (U21)
	B08 Understanding what is meant by activity	5.0%	+1.34(26-30), +.39 (30+)
	B10 Learning how to interpret the graphs	4.7%	+ .31 (21-25) -.51 (26-30)
<b>W01</b>	<b>Cohesiveness</b>		
	C02 I know other students in this class	4.8%	+ .46 (30+) -.31 (21-25)
<b>W02</b>	<b>Teacher Support</b>		
	C12 The teacher helps me when I have trouble with work	4.5%	+ .85 (26-30), +.08 (U21) -.92 (21-25)
	C14 The teacher is interested in my problems	4.2%	+ .24 (30+) -.16 (26-30)

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<b>W04</b>	<b>Investigation</b>			
	C30	I carry out investigations to answer teacher's questions	5.0%	+ .74 (26-30), + .16 (21-25) -.27 (U21)
<b>W05</b>	<b>Task Orientation</b>			
	C38	I pay attention during this class	6.1%	+ .50 (U21) -.33 (21-25)

---

In this table, only significant effects (at  $p < .05$ ) are shown. Although statistically significant, the effect sizes were relatively modest: all were less than 10%. After controlling for other indicators of Perceived Usefulness, students who were above 30 years of age found it harder to endorse the statement of seeing the graph showing the time spent useful than DID students under 21 and between 26 AND 30 years of age. After controlling for other indicators of Perceived Usefulness, students who are between 26 and 30 years of age found it harder to endorse the statement of being able to have one-to-one exclusive time discussing learning with the tutor. After controlling for other indicators of Perceived Ease of Use, students who are between 21 and 25 years of age found it harder to endorse the statement of being able to understand the graph, than did students under 21. After controlling for other indicators of Perceived Ease of Use, students who are between 26 and 30, and above 30 years of age found it harder to endorse the statement of being able to understand what is meant by the activity. After controlling for other indicators of Perceived Ease of Use, students who are between 21 and 25 years of age found it harder to endorse the statement of learning how to interpret the graphs.

After controlling for other indicators of Cohesiveness, students who are above 30 years of age, found it harder to endorse the statement that they know other students in this class. After controlling for other indicators of Teacher Support, students who are aged between 26 and 30, and under 21 years of age found it harder to endorse the statement that the teacher helps them when they have trouble with work than did students between 21 to 25 years of age. After controlling for other indicators of Teacher Support, students who are above 30 years of age found it harder to endorse the statement that the teacher is interested in their problems than did students between 26 and 30 years of age. After controlling for other indicators of Investigation, students who are aged between 26

and 30, and between 21 and 25 years of age found it harder to endorse the statement that they carry out investigations to answer the teacher's questions than did students under 21 years of age. After controlling for other indicators of Task Orientation, students who are under 21 years of age found it harder to endorse the statement that they pay attention during this class than did students from 21 to 25 years of age.

Differential item functioning has been explored in the WIHIC research by Mappiasse (2006) and Lai and Li in the TAM research (2005)

## 6.6. RESULTS

Twenty two hypotheses, summarising the findings expected from the literature review, were set out in Chapter Four. The first 14 relate to the association of the seven WIHIC scales with Perceived Usefulness and Perceived Ease of Use:

- H1a: Task Orientation will be positively associated with Perceived Usefulness
- H1b: Teacher Support will be positively associated with Perceived Usefulness
- H1c: Investigation will be positively associated with Perceived Usefulness
- H1d: Involvement will be positively associated with Perceived Usefulness
- H1e: Equity will be positively associated with Perceived Usefulness
- H1f: Cooperation will be positively associated with Perceived Usefulness
- H1g: Student Cohesiveness will be positively associated with Perceived Usefulness
- H2a: Task Orientation will be positively associated with Perceived Ease of Use
- H2b: Teacher Support will be positively associated with Perceived Ease of Use
- H2c: Investigation will be positively associated with Perceived Ease of Use
- H2d: Involvement will be positively associated with Perceived Ease of Use
- H2e: Equity will be positively associated with Perceived Ease of Use

- H2f: Cooperation will be positively associated with Perceived Ease of Use
- H2g: Student Cohesiveness will be positively associated with Perceived Ease of Use

These are tested by investigating the first order correlation between the respective scales. The primary method is to calculate the magnitude and significance of the Pearson correlation between the measures, but where there is doubt about the underlying assumptions of the Pearson coefficient, a non-parametric approach is used. Normality is tested by a Jarque-Bera test (1987). Should the data fail this test, a Spearman rank order correlation test is carried out, supported by a test of strict monotonic association (Gamma test).

The remaining eight hypotheses relate to the variation of Perceived Usefulness and Perceived Ease of Use across various demographic categories:

- H3: Male perception of Perceived Usefulness will be more positive than females.
- H4: Female perception of Ease of Use will be more positive than males.
- H5: Older students will have more positive perceptions of Perceived Usefulness than younger students.
- H6: Older students will have more positive perceptions of Perceived Ease of Use than younger students.
- H7: Students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience.
- H8: Students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience.
- H9: Students with English as a first language will have a more positive perception of Perceived Ease of Use than students with another first language.
- H10: Students with a non-English speaking background are likely to have higher perceptions of Perceived Usefulness than English speaking background students.

The approach to testing this group of hypotheses is to compare the means of the groups using ANOVA. Should the data fail to meet the assumptions of ANOVA, non-parametric tests are used. These comprise a Kruskal-Wallis test comparing ranks across groups, supported by a van der Waerden test of the plausibility that the samples are drawn from a single population.

The results of each test are presented below.

H1a: Task Orientation will be positively associated with Perceived Usefulness

A Pearson correlation analysis produced a correlation of 0.3534 between Cohesiveness (W01) and Perceived Usefulness of software (PU). However, the data do not conform to the normality assumptions of the Pearson coefficient. Accordingly, non-parametric tests of association were carried out to elaborate the degree of association. A Spearman's rank correlation test ( $r_s = 0.3503$ ;  $p < .0001$ ) shows a positive relationship. A test of strict monotonic association (Gamma=0.2469;  $p = 0.0002$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that this hypothesis is supported.

H1b: Teacher Support will be positively associated with Perceived Usefulness

A Pearson correlation between Teacher Support (W02) and Perceived Usefulness of software (PU) was 0.3677. However, the data do not conform to the normality assumptions of the Pearson coefficient. Again, a Spearman's rank correlation test ( $r_s = 0.3537$ ;  $p < .0001$ ) shows a positive relationship. The Gamma test (Gamma=0.2461;  $p = 0.0002$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that the hypothesis is supported.

H1c: Investigation will be positively associated with Perceived Usefulness

A Pearson correlation between Involvement (W03) and Perceived Usefulness of software (PU) was 0.2267. Again, the data do not conform to the normality assumptions of the Pearson coefficient. Again, a Spearman's rank correlation test

( $r_s = 0.2064$ ;  $p = 0.0024$ ) shows a positive relationship. The Gamma test ( $\text{Gamma} = 0.1465$ ;  $p = 0.0306$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that the hypothesis is supported.

H1d: Involvement will be positively associated with Perceived Usefulness

A Pearson correlation between Investigation (W04) and Perceived Usefulness of software (PU) was 0.2505. Again, the data do not conform to the normality assumptions of the Pearson coefficient. Accordingly, a Spearman's rank correlation test ( $r_s = 0.2360$ ;  $p = 0.0006$ ) and a test of strict monotonic association ( $\text{Gamma} = 0.1656$ ;  $p = 0.0144$ ), both show a positive ordinal relationship, significant at the  $p < 0.05$  level. It is therefore concluded that the hypothesis is supported.

H1e: Equity will be positively associated with Perceived Usefulness

A Pearson correlation between Task Orientation (W05) and Perceived Usefulness of software (PU) was 0.4124. Again, the data do not conform to the normality assumptions of the Pearson coefficient, a Spearman's rank correlation test ( $r_s = 0.4181$ ;  $p < .0001$ ) shows a positive relationship. The Gamma test ( $\text{Gamma} = 0.2915$ ;  $p < .0001$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that the hypothesis is supported.

H1f: Cooperation will be positively associated with Perceived Usefulness

A Pearson correlation between Cooperation (W06) and Perceived Usefulness of software (PU) was 0.3933. Again, the data do not conform to the normality assumptions of the Pearson coefficient, a Spearman's rank correlation test ( $r_s = 0.4072$ ;  $p < .0001$ ) shows a positive relationship. The Gamma test ( $\text{Gamma} = 0.2836$ ;  $p < .0001$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that the hypothesis is supported.

H1g: Student Cohesiveness will be positively associated with Perceived Usefulness

A Pearson correlation between Equity (W07) and Perceived Usefulness of software (PU) was 0.3679. Again, the data do not conform to the normality assumptions of the Pearson coefficient, a Spearman's rank correlation test ( $r_s = 0.3718$ ;  $p < .0001$ ) shows a positive relationship. The Gamma test of strict monotonic association (Gamma=0.2566;  $p = 0.0001$ ) shows a positive ordinal relationship. Both of these are significant at the  $p < 0.05$  level, so it is concluded that the hypothesis is supported.

H2a: Task Orientation will be positively associated with Perceived Ease of Use

A Pearson correlation between Cohesiveness (W01) and Perceived Ease of Use (PEU) was 0.3072. This was significant at the 0.05 level ( $r(216) = 0.3072$ ;  $p < .0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Cohesiveness (W01). The relationship accounts for 9% of the variability; adjusted R<sup>2</sup> was 9%. A Jarque-Bera test of normality indicates ( $p = 0.1925$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. It is concluded that the hypothesis is supported.

H2b: Teacher Support will be positively associated with Perceived Ease of Use

A Pearson correlation between Teacher Support (W02) and Perceived Ease of Use (PEU) was 0.3393. This was significant at the 0.05 level ( $r(216) = 0.3393$ ;  $p < .0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Teacher Support (W02). The relationship accounts for 12% of the variability; adjusted R<sup>2</sup> was 11%. A Jarque-Bera test of normality indicates ( $p = 0.1756$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. It is concluded that the hypothesis is supported.

H2c: Investigation will be positively associated with Perceived Ease of Use

A Pearson correlation analysis produced a correlation of 0.2564 between Involvement (W03) and Perceived Ease of Use (PEU). This was significant at the 0.05 level ( $r(216)=0.2564$ ;  $p<.0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Involvement (W03). The relationship accounts for 7% of the variability; adjusted R<sup>2</sup> was 6%. A Jarque-Bera test of normality indicates ( $p=0.2579$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. It is concluded that the hypothesis is supported.

H2d: Involvement will be positively associated with Perceived Ease of Use

A Pearson correlation between Investigation (W04) and Perceived Ease of Use (PEU) was 0.3106. This was significant at the 0.05 level ( $r(216)=0.3106$ ;  $p<.0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Investigation (W04). The relationship accounts for 10% of the variability; adjusted R<sup>2</sup> was 9%. A Jarque-Bera test of normality indicates ( $p=0.1469$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. Accordingly, it is concluded that the hypothesis is supported.

H2e: Equity will be positively associated with Perceived Ease of Use

A Pearson correlation between Task Orientation (W05) and Perceived Ease of Use (PEU) was 0.3648. This was significant at the 0.05 level ( $r(216)=0.3648$ ;  $p<.0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Task Orientation (W05). The relationship accounts for 13% of the variability; adjusted R<sup>2</sup> was 13%. A Jarque-Bera test of normality indicates ( $p=0.1481$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. Accordingly, it is concluded that the hypothesis is supported.

H2f: Cooperation will be positively associated with Perceived Ease of Use

A Pearson correlation between Cooperation (W06) and Perceived Ease of Use (PEU) was 0.2450. This was significant at the 0.05 level ( $r(216)=0.2450$ ;  $p=0.0002$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Cooperation (W06). The relationship accounts for 6% of the variability; adjusted R<sup>2</sup> was 6%. A Jarque-Bera test of normality indicates ( $p=0.0694$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. Accordingly, it is concluded that the hypothesis is supported.

H2g: Student Cohesiveness will be positively associated with Perceived Ease of Use

A Pearson correlation between Equity (W07) and Perceived Ease of Use (PEU) was 0.3205. This was significant at the 0.05 level ( $r(216)=0.3205$ ;  $p<.0001$ ), with higher values of Perceived Ease of Use (PEU) associated with higher values of Equity (W07). The relationship accounts for 10% of the variability; adjusted R<sup>2</sup> was 10%. A Jarque-Bera test of normality indicates ( $p=0.0772$ ) that the distribution of the residual from the regression is acceptably close to a normal distribution, which suggests that a parametric approach is appropriate. Accordingly, it is concluded that the hypothesis is supported.

H3: Male perception of Perceived Usefulness will be more positive than females.

A One-way ANOVA comparison of means of Perceived Usefulness of software (PU) across categories of gender (D02) found no significant differences ( $F(1, 207)=1.06$ ;  $\eta^2=0.51\%$ ;  $\omega^2=0.03\%$ ;  $p=0.3042$ ). However, the data do not meet the parametric assumptions of ANOVA because neither the female group ( $p=.0352$ ), nor the male group ( $p=.0064$ ) were normally distributed. Accordingly, a non-parametric Kruskal-Wallis test comparing ranks of Perceived Usefulness of software (PU) across categories of gender (D02) was also carried out. This was not significant ( $H(1)=1.50$ ;  $\phi C=0.0848$ ;  $\phi C^2=0.7\%$ ;  $p=0.2204$ ), and an independent samples van der Waerden

test, treating each category as a separate sample, reported a significance of  $p=0.2198$  which suggests that it is plausible that the samples were drawn from a single population.

From all of these tests, it is concluded that this hypothesis is not supported.

H4: Female perception of Ease of Use will be more positive than males.

A one-way ANOVA comparison of means of Perceived Ease of Use (PEU) across categories of gender (D02) detected a significant ( $F(1, 207)=8.25$ ;  $\eta^2=3.83\%$ ;  $\omega^2=3.35\%$ ;  $p=0.0046$ ) difference in means (see Table 6.10).

Table 6.10.

*A One-way ANOVA Comparison of Means between PEU Across Categories of Gender*

Component	SS	Df	MS	F	Significance
Model	49.66	1	49.66	8.25	0.0046
Residual	1245.63	207	6.02		
Total	1295.29	208			

However, the hypothesis is not supported; the mean endorsement of Perceived Ease of Use was higher among males than females (see Table 6.11).

Table 6.11.

*The Mean Endorsement of Perceived Ease of Use of Males and Females*

Category	Mean	N	Variance
Female	5.80	79	8.02
Male	6.81	130	4.81

Moreover, the data do not meet the parametric assumptions of ANOVA because the variance is not homogeneous across groups; the ratio of the smallest to the largest is 1.67 and an O'Brien test of homogeneity suggests ( $F(1, 207)=9.41$ ;  $\eta^2=4.35\%$ ;  $\omega^2=3.87\%$ ;  $p=0.0026$ ) that this is unacceptable.

Accordingly, a non-parametric Kruskal-Wallis test comparing ranks of Perceived Ease of Use (PEU) across categories of gender (D02) was also carried out. This was significant ( $H(1)=6.48$ ;  $\phi C=0.1761$ ;  $\phi C^2=3.1\%$ ;  $p=0.0109$ ), and an independent samples van der Waerden test, treating each category as a separate sample, reported a significance of  $p=0.0076$  which suggests that the samples were not drawn from a single population. However, the Kruskal-Wallis test (see Table 6.12) confirmed the ANOVA finding that endorsement of Perceived Ease of Use was higher among males than females.

Table 6.12.

*Kruskal-Wallis test*

Category	std rank
Female	49%
Male	70%

It is concluded that the hypothesis is not supported. Indeed, endorsement of Perceived Ease of Use was significantly higher among males than females.

H5: Older students will have more positive perceptions of Perceived Usefulness than younger students.

A comparison of means of Perceived Usefulness of software (PU) across categories of your age on your last birthday (D01) found no significant differences ( $F(3, 204)=0.74$ ;  $\eta^2=1.07\%$ ;  $\omega^2=-0.38\%$ ;  $p=1.0000$ ). However, the data do not meet the parametric assumptions of ANOVA because the 21 to 25 age group is not normally distributed ( $p=.0004$ ). Accordingly, a non-parametric Kruskal-Wallis test comparing ranks of Perceived Usefulness of software (PU) across categories of age on last birthday (D01) was carried out. This also was not significant ( $H(3)=3.83$ ;  $\phi C=0.0784$ ;  $\phi C^2=0.6\%$ ;  $p=0.2802$ ), and an independent samples van der Waerden test, treating each category as a separate sample, reported a significance of  $p=0.4084$ , which suggests that it is plausible that the samples were drawn from a single population.

The standardised ranks of the various categories are shown in Table 6.13. From these, it can be seen that Perceived Usefulness increases across the age groups, but falls off in the 30 or older age group. Moreover, the difference of 11.8% between

the under 21 group and the 21 to 25 group falls just short of the honestly significantly difference of 12.1%.

Table 6.13.

*Perceived Usefulness as standardised ranks of various categories of age*

U2.	21-25	26-30	30+
29.7%	41.5%	42.4%	37.7%

From these results, it is concluded that the hypothesis is not supported.

H6: Older students will have more positive perceptions of Perceived Ease of Use than younger students

A one-way ANOVA comparison of means of Perceived Ease of Use (PEU) across categories of your age on your last birthday (D01) found no significant differences. ( $F(3, 204)=0.86$ ;  $\eta^2=1.24\%$ ;  $\omega^2=-0.21\%$ ;  $p=1.0000$ ). The data meet the parametric assumptions of ANOVA because variance was acceptably homogeneous across groups (the ratio of the smallest to the largest is 1.14) and all samples were acceptably close to a normal distribution.

The standardised ranks of the various categories are shown in Table 6.14. From these, it can be seen that Perceived Ease of Use is higher in the age groups for under 21 and for 30 or more, but lower in the two intermediate groups. However, the difference of 7.5% between the under 21 group and the 21 to 25 age group falls short of the honestly significant difference of 11.0%.

Table 6.14.

*Perceived Ease of Use of standardised ranks of the age categories*

U21	21-25	26-30	30+
49.3%	41.8%	43.5%	51.7%

From these results, it is concluded that the hypothesis is not supported.

H7: Students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience.

A one-way ANOVA comparison of means of Perceived Usefulness of software (PU) across categories of how a student spent most of their time in the six months prior to starting the course (D05) was carried out ( $F(3, 204)=2.74$ ;  $\eta^2=3.87\%$ ;  $\omega^2=2.45\%$ ;  $p=0.0437$ ). However, the data did not meet the parametric assumptions of ANOVA because the group of those who were studying in the previous semester was not normally distributed ( $p=.0003$ ). Accordingly, an equivalent non-parametric Kruskal-Wallis test comparing ranks was carried out. The Kruskal-Wallis test was significant ( $H(3)=8.84$ ;  $\phi C=0.1190$ ;  $\phi C^2=1.4\%$ ;  $p=0.0315$ ) and this was supported by an independent samples van der Waerden test, treating each category as a separate sample, which reported a significance of  $p=0.0473$ , thus suggesting that the samples were not drawn from a single population. The standardised ranks from the Kruskal-Wallis test are shown in Table 6.15.

Table 6.15.

*Standardised ranks from the Kruskal-Wallis test*

Category	std rank	Other	Studying	Working
Working and studying	56%	***	Ns	ns
Working	47%	***	ns	
Studying	51%	***		
Other	32%			

Note: 'ns' indicates no significant difference; \*\*\* denotes a significant difference.

There was no significant difference between working, studying, and working and studying groups. Significant difference was found between the other category and each of the remaining categories: working, studying, and working and studying. In each case, the other category had a lower endorsement of Perceived Usefulness. The strength of endorsement follows the hypothesised order, but the working and studying group, although higher than each of the working and studying categories, was not significantly higher at this sample size. However, the pattern is sufficiently clear that, from these data, it is concluded that the hypothesis is weakly supported.

H8: Students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience.

A one-way ANOVA comparison of means of Perceived Ease of Use (PEU) across categories of how students spent most of their time in the six months prior to starting the course (D05) detected a significant ( $F(3, 204)=4.31$ ;  $\eta^2=5.96\%$ ;  $\omega^2=4.56\%$ ;  $p=0.0058$ ) difference in means. The data meet the parametric assumptions of ANOVA because all samples were acceptably close to a normal distribution and variance was acceptably homogeneous across groups (the ratio of the smallest to the largest was 2.24). A summary of the ANOVA is shown in Table 6.16 .

Table 6.16.

*A summary of the ANOVA*

Component	SS	Df	MS	F	Significance
Model	77.98	3	25.99	4.31	0.0058
Residual	1229.81	204	6.03		
Total	1307.80	207			

Mean values for each of the categories are summarised in Table 6.17.

Table 6.17.

*Summary of mean values for each of the categories*

Category	Mean	N	Variance
Working and studying	7.99	12	3.10
Studying	6.64	116	5.97
Working	6.26	49	6.95
Other	5.26	31	5.86

The hypothesis that students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience is not supported. The working and studying category has the highest mean of any category.

H9: Students with English as a first language will have a more positive perception of Ease of Use than students with another first language.

A one-way ANOVA comparison of means of Perceived Ease of Use (PEU) across categories of first language was carried out ( $F(1, 208)=1.55$ ;  $\eta^2=0.74\%$ ;  $\omega^2=0.26\%$ ;

$p=0.2126$ ). The data meet the parametric assumptions of ANOVA because variance is acceptably homogeneous across groups (the ratio of the smallest to the largest is 1.26) and all samples are acceptably close to a normal distribution.

Although those with English as a first language gave higher ratings of Perceived Ease of Use, the difference was not significant and this lack of significance was confirmed by a non-parametric Kruskal-Wallis test ( $H(1)=1.84$ ;  $\phi C=0.0937$ ;  $\phi C^2=0.9\%$ ;  $p=0.1745$ ) and an independent samples van der Waerden test ( $p=0.1715$ ). Accordingly, it was concluded that this hypothesis was not supported.

H10: Students with a first language other than English are likely to have higher perceptions of Usefulness than those with English as a first language.

A one-way ANOVA comparison of means of Perceived Usefulness of software (PU) across categories of is English your first language (D04) was carried out ( $F(1, 208)=16.32$ ;  $\eta^2=7.28\%$ ;  $\omega^2=6.80\%$ ;  $p=0.0001$ ). However, the data did not meet the parametric assumptions of ANOVA because the group of those who did not have English as a first language was not normally distributed ( $p<.0001$ ). Accordingly, a non-parametric Kruskal-Wallis test comparing ranks of Perceived Usefulness of software (PU) across categories of first language was also carried out ( $H(1)=15.68$ ;  $\phi C=0.2732$ ;  $\phi C^2=7.5\%$ ;  $p=0.0001$ ). The Kruskal-Wallis test was significant at the  $p < .05$  level and this was further supported by an independent samples van der Waerden test, treating each category as a separate sample, which reported a significance of  $p=0.0002$ , thus suggesting that the samples were not drawn from a single population. The respective ranks are shown in Table 6.18.

Table 6.18.

*Standardised ranks for first language*

First Language	Standardised rank
Not English	67%
English	35%

Those who did not have English as a first language rated Perceived Usefulness of the software higher than those who declared English as a first language. The

difference in ranks of 32% is substantially larger than the honestly significant difference of 3.7%. From these results, it is concluded that the hypothesis is supported.

### 6.6.1. SUMMARY OF RESULTS

The above results are summarised in Table 6.19.

Table 6.19.

*The summary of the results of testing of hypotheses H1a to H10*

	Hypothesis	Result
H1a	Task Orientation will be positively associated with Perceived Usefulness	Supported
H1b	Teacher Support will be positively associated with Perceived Usefulness	Supported
H1c	Investigation will be positively associated with Perceived Usefulness	Supported
H1d	Involvement will be positively associated with Perceived Usefulness	Supported
H1e	Equity will be positively associated with Perceived Usefulness	Supported
H1f	Cooperation will be positively associated with Perceived Usefulness	Supported
H1g	Student Cohesiveness will be positively associated with Perceived Usefulness	Supported
H2a	Task Orientation will be positively associated with Perceived Ease of Use	Supported
H2b	Teacher Support will be positively associated with Perceived Ease of Use	Supported
H2c	Investigation will be positively associated with Perceived Ease of Use	Supported
H2d	Involvement will be positively associated with Perceived Ease of Use	Supported
H2e	Equity will be positively associated with Perceived Ease of Use	Supported
H2f	Cooperation will be positively associated with Perceived Ease of Use	Supported
H2g	Student Cohesiveness will be positively associated with Perceived Ease of Use	Supported
H3	Male perception of Usefulness will be more positive than females.	Not supported
H4	Female perception of Ease of Use will be more positive than males.	Rejected
H5	Older students will have more positive perceptions of Usefulness than younger students.	Not supported
H6	Older students will have more positive perceptions of Perceived Ease of Use than younger students	Not supported
H7	Students with broader life experience will have more positive perceptions of Usefulness than students with narrower experience.	Weakly supported

H8	Students with broader life experience will have less positive perceptions of Ease of Use than students with narrower experience	Rejected
H9	Student with English as a first language will have a more positive perception of Ease of Use than students with another first language	Not supported
H10	Students with a first language other than English are likely to have higher perceptions of Usefulness than those with English as a first language.	Supported

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Hypothesis H1(a-g) and Hypotheses2(a-g) were supported. Hypotheses H3, H4, H5, H6, H8, H9, and H10 were not supported. Only hypothesis H7 was weakly supported. A discussion of these results is presented in section 6.8.

### 6.7. PATH ANALYSIS

The conceptual model for the relationships between the WIHIC subscales and the TAM scales is presented in Figure 4-3. Although a positive relationship was found for each of hypotheses H1a to H2g as presented in the previous section, the WIHIC subscales are inter-related. The goal in this section is to unpick some of these relationships, so as to identify the unique contribution made by each subscale. The technique used is that of multiple regression: each of the WIHIC variables (scales) is used as a predictor, and the TAM variables (Perceived Usefulness and Perceived Ease of Use) as criterion variables. The starting point in the analysis was to include all the WIHIC variables in the analysis. The path diagram of this initial regression is shown in Figure 6-3.

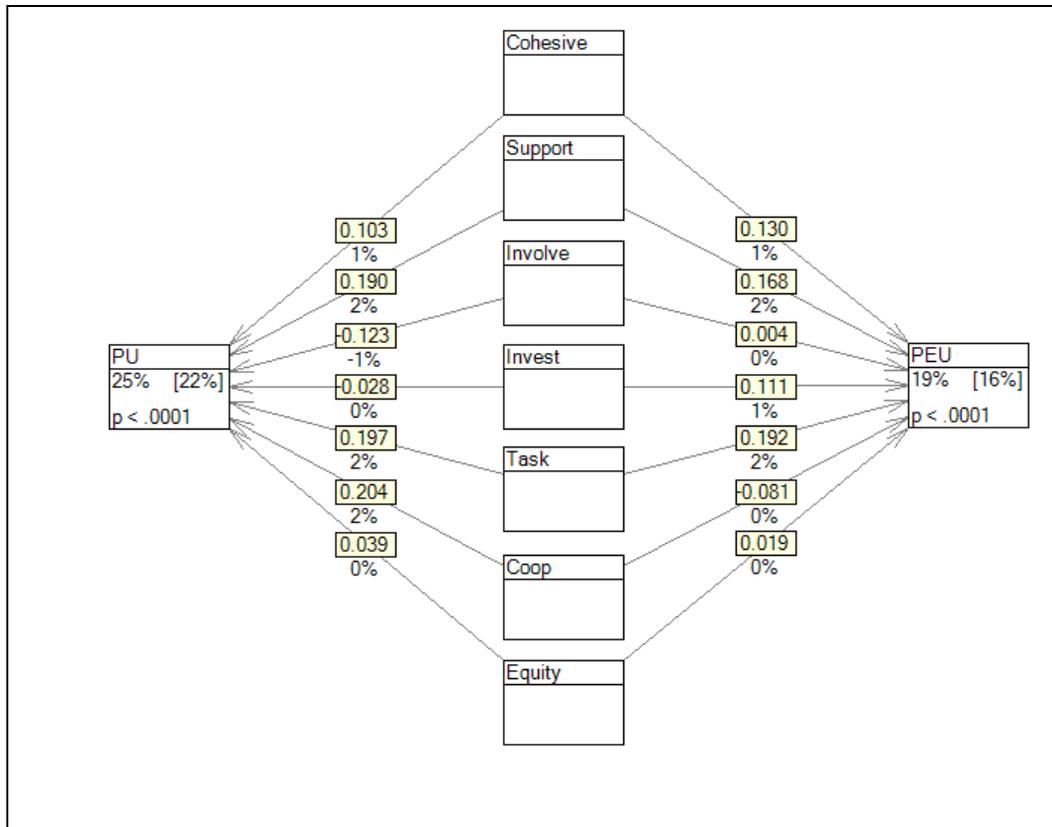


Figure 6-3. WIHIC and TAM variables initial regression.

In this diagram, each variable is shown in a titled box. For predictor variables, the box is empty. For criterion variables, the box shows three figures. The first is the percentage of gross variance ( $R^2$ ) explained by the regression. This is followed by the adjusted variance (adj.  $R^2$ ) in square brackets. The adjustment attempts to identify a more accurate estimate of variance explained after controlling for chance variation. This is followed by the significance level of the regression. An arrow is drawn from each predictor variable to each criterion variable and includes an untitled box. This box shows the *Beta* weight of the relationship. Underneath the box, the semi-partial correlation is shown; this is the unique proportion of variance in the criterion explained by the predictor.

It can be seen that the unique contribution made by some of the predictors is close to zero: these predictors add little to what is predicted by the other variables. To eliminate some of these, and thus form a clearer picture of which variables make a significant contribution to the prediction, a process of stepwise predictor elimination was carried out. In this process, the least significant predictor is

identified and eliminated from the model. The model is then run again and the elimination process is repeated until all retained predictors make a significant contribution, or all variables are eliminated. After eliminating these variables, all remaining predictors made a significant contribution to the regression. The ANOVA for the respective regressions is shown in Table 6.20.

Table 6.20.

*ANOVA for the WIHIC Regression*

Criterion	Component	Sum of Squares	df	Mean square	F	Significance
Perceived Usefulness	Model	351.55	2	175.78	28.25	0.0000
	Residual	1337.61	215	6.22		
	Total	1689.17	217			
Perceived Ease of Use	Model	250.09	2	125.04	21.81	0.0000
	Residual	1232.83	215	5.73		
	Total	1482.91	217			

The modelled values for the regression are shown in Table 6.21.

Table 6.21.

*Modelled Values for the WIHIC Regression*

Criterion	Predictor	Beta	T	Significance	VIF	$r_0$	$r_p$	$r_{sp}$
Perceived Usefulness	Support	0.222	3.21	0.0017	1.292	0.368	0.214	0.195
	Task	0.307	4.45	0.0000	1.292	0.412	0.290	0.270
Perceived Ease of Use	Support	0.214	3.03	0.0029	1.292	0.339	0.203	0.189
	Task	0.263	3.72	0.0003	1.292	0.365	0.246	0.231

Table 6.21 shows each predictor and its *Beta* weight; a t-statistic for its contribution and the corresponding significance; the variance inflation factor (VIF) which identifies variance shared with other predictors; and finally the zero order correlation ( $r_0$ ), the partial correlation ( $r_p$ ) and the semi-partial correlation ( $r_{sp}$ ). The path diagram resulting from the elimination of those predictors not making a significant contribution is shown in Figure 6-4.

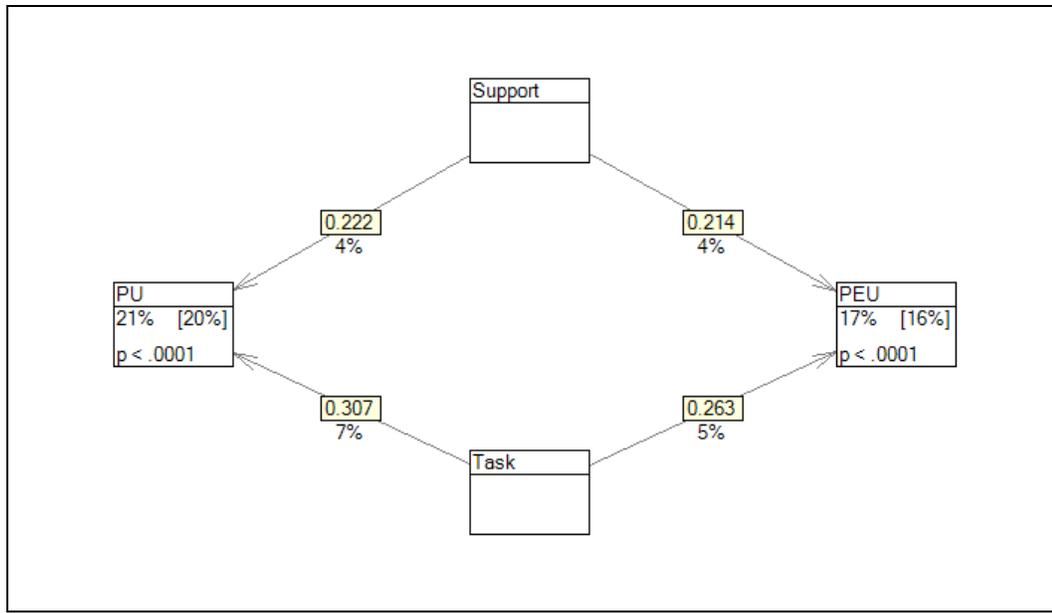


Figure 6-4. Path diagram with WIHIC main predictors.

From this diagram, it can be seen that two of the WIHIC variables (Teacher Support and Task Orientation) explain almost as much of the overall variance as the full set of variables: adjusted  $R^2$  is 20% rather than 22% for PU and remains at 16% for PEU.

### 6.7.1. BACKGROUND DEMOGRAPHICS

The conceptual model for relationships between the demographic variables and the TAM variables was set out in Figure 4-4. To enable analysis by multiple regression, the prior experience category was recoded into two dichotomous variables (Working and Studying), and the age category was recoded into an interval variable (Age) by assigning nominal values of 18, 23, 28 and 33 to the respective age categories. For consistency, Gender and Language were also coded as dichotomous variables with the name taken from the upper category. Thus Working, Studying, Female, and English, all refer to the state in which the category matches the name used. The initial analysis is shown in Figure 6-5.

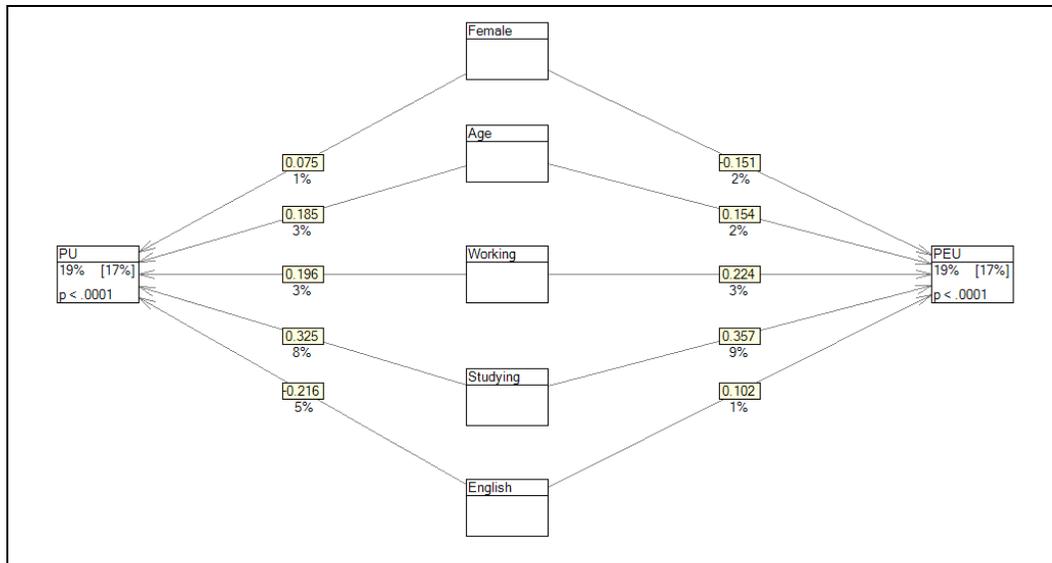


Figure 6-5. Path diagram for demographic predictors.

As with the WIHC variables, a process of stepwise predictor variable elimination was carried out. The relationships between the demographic variables were also mapped and non-significant associations were likewise eliminated. After eliminating these variables, all remaining predictors made a significant contribution to the regressions.

The ANOVA for the respective regressions is shown in Table 6.22.

Table 6.22.

ANOVA for Demographic Regression

Criterion	Component	Sum of Squares	df	Mean square	F	Significance
Perceived Usefulness	Model	193.50	2	96.75	13.91	0.0000
	Residual	1496.67	215	6.96		
	Total	1689.17	217			
Perceived Ease of Use	Model	177.06	2	88.53	14.58	0.0000
	Residual	1305.86	215	5.85		
	Total	1482.91	217			
Working	Model	4.34	1	4.34	23.04	0.0000
	Residual	38.77	206	0.19		
	Total	43.11	207			
Studying	Model	3.26	1	3.6	14.62	0.0002
	Residual	45.97	206	0.22		
	Total	49.23	207			

The modelled values for the predictors from the regression are shown in Table 6.23.

Table 6.23.

*Modelled Values for Demographic Predictors*

Criterion	Predictor	Beta	T	Significance	VIF	r <sub>0</sub>	r <sub>p</sub>	r <sub>sp</sub>
Perceived Usefulness	Age	0.242	3.76	0.0003	1.00	0.251	0.249	0.241
	Studying	0.227	3.53	0.0006	1.00	0.237	0.234	0.227
Perceived Ease of Use	Age	0.223	3.57	0.0006	1.00	0.242	0.237	0.229
	Studying	0.247	3.86	0.0002	1.00	0.259	0.255	0.247
Working	Age	0.317	4.80	0.0000	-	-	-	-
Studying	Age	-0.257	-3.82	0.0002	-	-	-	-

It can be seen that only age and studying made a significant contribution to the explanation of Perceived Usefulness and Perceived Ease of Use. Moreover, the only significant relationship found among the demographic variables was that Age was a significant predictor of whether a student had been working before studying in the course and negative predictors of whether they had previously been studying. The resulting path diagram for the association between the demographic variables and the TAM variables, together with the significant associations among the demographic variables, is shown in Figure 6-6.

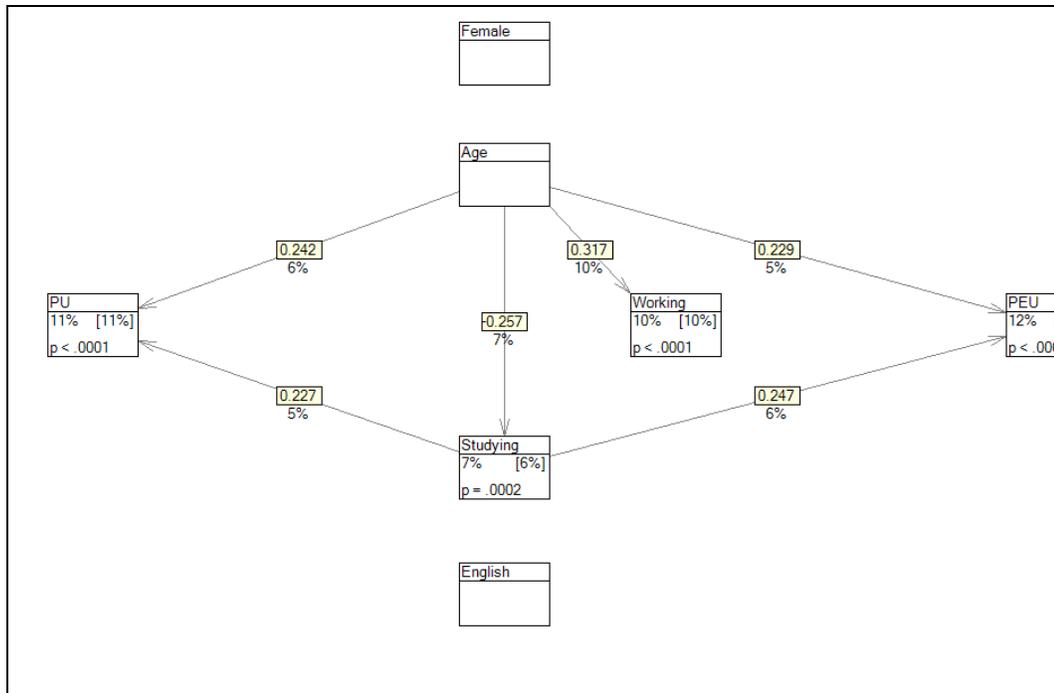


Figure 6-6. The resulting path diagram for demographic and TAM variables.

The diagram shows that age explains 6% of the variation in Perceived Usefulness. Whether or not the student was studying explains another 5% of Perceived Usefulness. Age explains 5% of variation in Perceived Ease of Use. Whether or not the student was studying explains another 6% of Perceived Ease of Use. The commonality between those two explains the last one percent of the total variation.

### 6.7.2. DEMOGRAPHIC VARIABLES AND THE WIHIC

The associations between the demographic variables and the WIHIC scales were also explored. The initial path diagram, showing all possible associations, is shown in Figure 6-7.

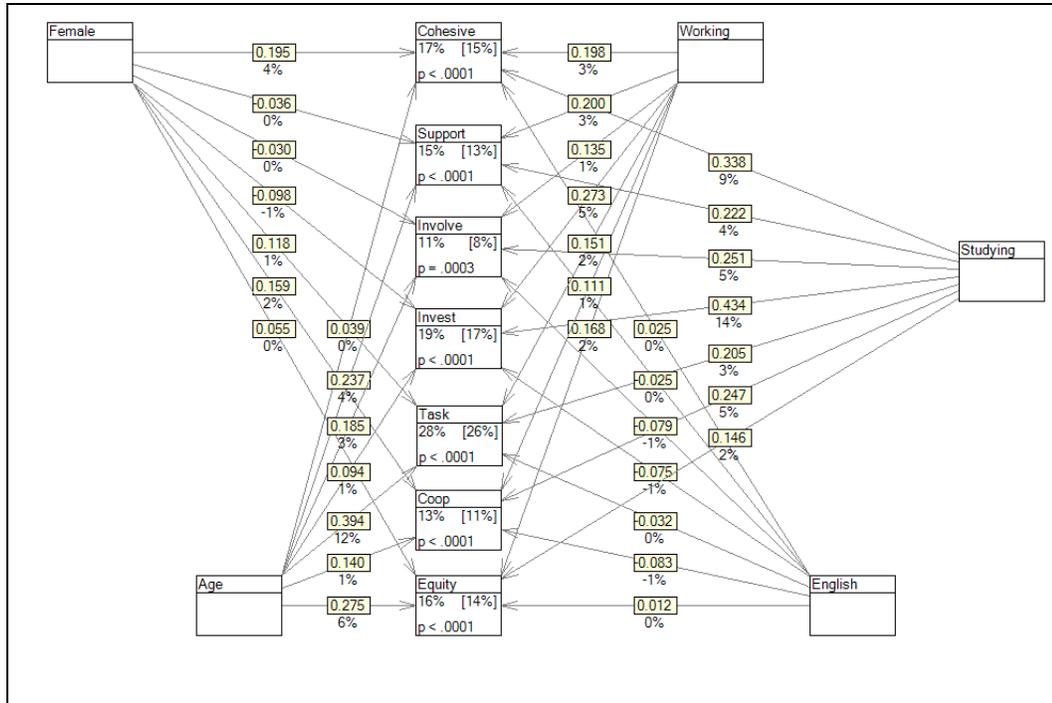


Figure 6-7. Path diagram for WIHIC and demographic variables.

Similar to the previous two path diagrams, a process of stepwise elimination of predictor variables was carried out. After eliminating these variables, all remaining predictors made a significant contribution to the regressions. The ANOVA for the respective regressions is shown in Table 6.24.

Table 6.24.

*ANOVA for Demographic and WIHIC Regression*

Criterion	Component	Sum of Squares	df	Mean square	F	Significance
Cohesiveness	Model	142.72	2	71.36	15.55	0.0000
	Residual	986.78	215	4.59		
	Total	1129.50	217			
Teacher Support	Model	190.37	2	95.18	14.60	0.0000
	Residual	1401.03	215	6.52		
	Total	1592.40	217			
Involvement	Model	128.93	2	64.46	10.26	0.0001
	Residual	1350.43	215	6.28		
	Total	1479.36	217			
Investigation	Model	227.11	2	113.56	15.74	0.0000
	Residual	1551.31	215	7.22		
	Total	1778.42	217			

Task Orientation	Model	341.16	2	170.58	34.20	0.0000
	Residual	1072.52	215	4.99		
	Total	1413.69	217			
Cooperation	Model	131.02	2	65.51	9.50	0.0002
	Residual	1482.22	215	6.89		
	Total	1613.25	217			
Equity	Model	232.70	1	232.70	31.91	0.0000
	Residual	1575.30	216	7.29		
	Total	1808.00	217			

The modelled values for the regressions are shown in Table 6.25.

Table 6.25.

*Modelled Values for WIHIC and Demographic Regression*

Criterion	Predictor	Beta	t	Significance	VIF	r <sub>0</sub>	r <sub>p</sub>	r <sub>sp</sub>
Cohesiveness	Female	0.221	3.44	0.0008	1.01	0.246	0.229	0.219
	Studying	0.258	4.02	0.0001	1.01	0.280	0.264	0.256
Teacher Support	Age	0.310	4.83	0.0000	1.01	0.321	0.313	0.309
	Studying	0.130	2.02	0.0421	1.01	0.155	0.137	0.129
Involvement	Age	0.223	3.42	0.0009	1.00	0.233	0.227	0.223
	Studying	0.181	2.78	0.0060	1.00	0.194	0.186	0.181
Investigation	Age	0.176	2.75	0.0064	1.01	0.197	0.185	0.175
	Studying	0.299	4.68	0.0000	1.01	0.311	0.304	0.298
Task Orientation	Age	0.451	7.47	0.0000	1.03	0.474	0.454	0.444
	Female	0.132	2.18	0.0288	1.03	0.211	0.147	0.129
Cooperation	Age	0.184	2.76	0.0062	1.04	0.221	0.185	0.181
	Female	0.184	2.76	0.0063	1.04	0.221	0.185	0.180
Equity	Age	0.359	5.65	0.1000	-	-	-	-

The resulting path diagram for the associations between the demographic variables and the WIHIC scales, after eliminating insignificant associations, is shown in Figure 6-8.

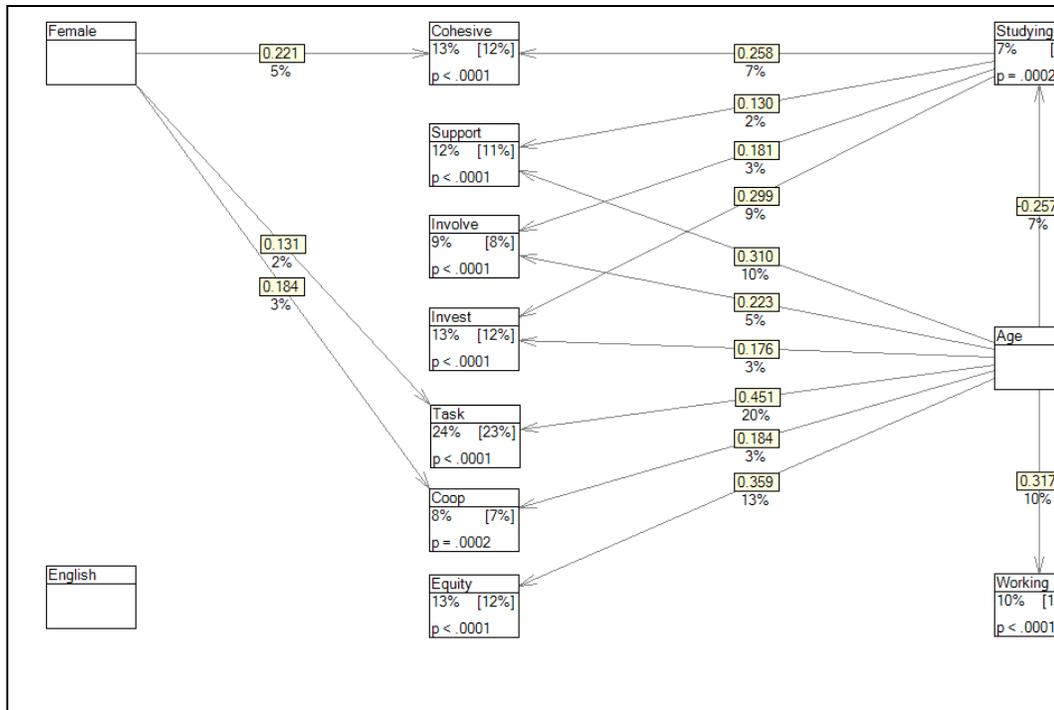


Figure 6-8. Associations between background demographics and the WIHIC scales.

The diagram shows that gender explains 5% of the variation in Cohesiveness. Whether or not the student was studying explains another 7% of Cohesiveness. The commonality between those two explains the last one percent of the total variation. Gender explains 2% of variation in Task Orientation. Although this is statistically significant at this sample size, the effect size is small. Age explains 20% of variation in Task Orientation and the remaining 2% is explained by the commonality between those two. Whether or not the student was studying explains 2% of variation in Teacher Support. Age explains 10% of variation in Teacher Support. Whether or not the student was studying explains 3% of variation in Involvement. Age explains 5% of variation in Involvement and the remaining 1% of the total is explained by the commonality between those two. Whether or not the student was studying explains 9% of variation in Investigation. Age explains 3% of variation in Investigation and the remaining 1% is explained by the commonality between those two. Gender explains 3% of variation in Cooperation. Age explains 3% of variation in Cooperation and the remaining 2% of the total is explained by the commonality between those two. Age explains 13% of the variation in Equity.

### 6.7.3. ETAM PATH DIAGRAM

The final stage carried out in this analysis was to bring the three path diagrams described above into a single comprehensive diagram corresponding to the ETAM model. As before, predictors not making a significant contribution were eliminated by a step wise procedure. The final path diagram is shown in Figure 6-9.

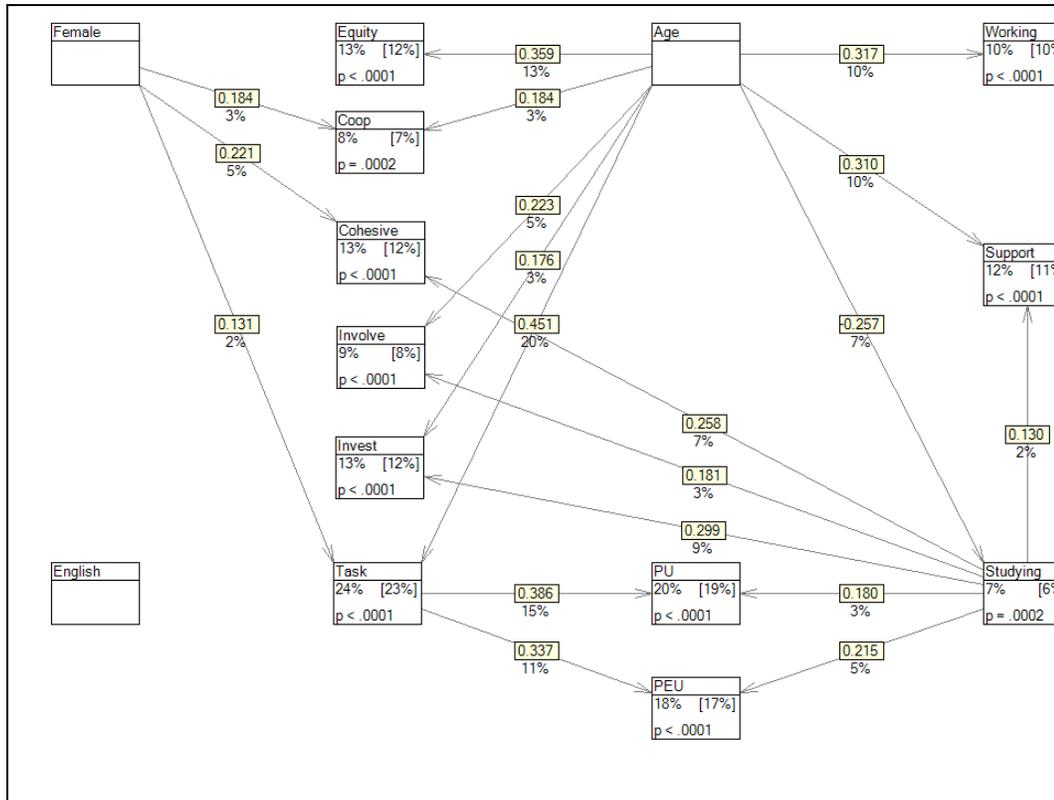


Figure 6-9. Path analysis of the ETAM model.

The diagram shows that gender explains 5% of the variation in Cohesiveness. Whether or not the student was studying explains another 7% of Cohesiveness. The commonality between those two explains the last one percent of the total variation. Gender explains 2% of variation of Task Orientation. Although this is statistically significant at this sample size, the effect size is small. Age explains 20% of variation in Task Orientation and the remaining 2% is explained by the commonality between those two. Whether or not the student was studying explains 9% of variation in Investigation. Age explains 3% of variation in Investigation and the remaining 1% is explained by the commonality between those two. Age explains 5% of variation in Involvement. Whether or not the student was

studying explains 3% of variation in Involvement and the remaining 1% of the total is explained by the commonality between those two. Gender explains 3% of variation in Cooperation. Age explains 3% of variation in Cooperation and the remaining 2% is explained by the commonality between those two. Age explains 13% of the variation in Equity.

Whether or not the student was studying explains 3% of variation in Perceived Usefulness. Task Orientation explains 15% of variation in Perceived Usefulness and the remaining 2% is explained by the commonality between those two. Whether or not the student was studying explains 5% of variation in Perceived Ease of Use. Task Orientation explains 11% of variation in Perceived Ease of Use and the remaining 2% is explained by the commonality between those two.

## **6.8. DISCUSSION**

### **6.8.1. HYPOTHESES DISCUSSION**

All of the first 14 hypotheses H1(a-g) and H2(a-g) were supported by the data. These hypotheses related to the association of the seven WIHIC scales with Perceived Usefulness and Perceived Ease of Use. This study has confirmed that there is a positive association between the environmental scales (seven WIHIC scales) and both TAM scales (Perceived Usefulness and Perceived Ease of Use). It has confirmed the findings of many studies undertaken in the investigation of educational environments. The educational environment studies used the WIHIC scales to investigate associations between the scales and the learning environment. Their findings reported a positive association between the environment and Student Cohesiveness, Task Orientation and Equity in the studies of Zandvliet (2003), She and Fisher (2003), Chionh and Fraser (1998). The positive association between environment and Teacher Support has been reported in the studies of Rawnsley and Fisher (1998) and many others. The TAM researchers have investigated technology acceptance in the educational environment as well (Askar & Umay, 2001; Huang & Liaw, 2005; Teo, Lee, & Chai, 2008; Teo, Lee, Ching, &

Wong, 2009; Wang & Wilson, 2005; Yildirim, 2000). Their findings suggested that attitude towards the intention to use will predict the use itself (Myers & Halpin, 2002). Huang and Liaw (2005) stated that the implementation of educational technology is completely dependent on the teacher having a positive attitude. The results the investigation reported in this thesis found positive relationships in all 14 hypotheses centred on the relationship between the WIHIC and the TAM constructs. This study has supported the findings of other studies which also found positive relationships between educational environment and different WIHIC constructs including attitude towards computing.

To identify the individual contribution of each WIHIC construct in perceived usefulness and perceived ease of use (hypotheses H1a to H2g), have been further analysed using path analysis. Path analysis is used to identify individual contributions as stated in the hypotheses because the WIHIC scales are inter-related. Path analysis has identified that two of the WIHIC scales, Teacher Support and Task Orientation explained almost as much of the overall variance as the full set of the WIHIC variables. Task Orientation and Teacher Support explained 20% of the variance in Perceived Usefulness and 16% of the variance in Perceived Ease of Use. Teacher Support has been reported in the literature as being important in technology implementation in classrooms (Aldridge & Fraser, 2003; Askar & Umay, 2001; Dorman & Fraser, 2009; Rawnsley & Fisher, 1998; Teo, 2006). It has to be noted that this study had computing students as a sample and therefore computing teachers. The attitude of the computing teachers towards the technology should be (in the majority of the cases) positive. This assumption is based on the fact that a positive attitude is needed to be able to cope with continuous change in technology and the continued requirement to accept new technology. To adjust to the new technology and master it on a regular basis and to be able to teach it requires a positive attitude.

Major changes in technology occur at the rate of a new one every three years. For example, the Microsoft Corporation is making considerable changes in the software and hardware on average every three years. Working in these ever changing environments one get use to the changes and has to develop a positive attitude

toward the change in order to cope with the stress of the change itself. People who have difficulty adjusting to these changes normally leave this field early in their career. It may be that this attitude then is communicated to students and that had then influenced their perception of Usefulness and Ease of Use. The second WIHIC construct, which was one of two major predictors for both PEU and PU, was Task Orientation. Task Orientation has been identified in many WIHIC studies (den Brook, Fisher, Rickards, & Bull, 2005; Margianti, 2003; She & Fisher, 2003) as having a positive association with the environment. The reason why Task Orientation was identified as one of the two major predictors of technology acceptance (which explained almost as much as all WIHIC scales), may lie in the influence of the practical component in the computing field. Most of the computing courses would have a practical component, which would require students to be engaged with the task individually and to be strongly focused to perform it effectively. The computing field is one of the fields with a strong practical component in the study which may help in keeping students more focused on the task and therefore may explain why Task Orientation is one of the major predictors of technology acceptance in this study's findings.

Hypothesis three (H3) that stated that male perception of Perceived Usefulness will be more positive than females, is not supported in this study. The literature in some studies suggests that there is a gender difference in perceptions of Perceived Usefulness. Males were assumed to hold more positive attitudes and be less anxious about technology innovations (Frances, 1994; Gilroy & Desai, 1986; Whitely, 1997). Several other studies confirmed that males are likely to be influenced by productivity related factors (Usefulness) and females by process (Ease of Use) when making technology adoption decision (Venkatesh & Morris, 2000). The different results in this thesis from other studies, suggests that gender may be an inconsistent predictor, and therefore studies specific to the area should be carried out before it is used as predictor. It suggests that researchers should include gender as study variable, but that the effect should be considered in the specific context of the technology being explored.

Some of the reasons why this hypothesis has not been supported in this study may lie in the fact that all participants were from computing degree classes, and as such use of the technology and its change by the nature of the domain of the study, is expected. It also may mean that the female participants of this study did not have a problem with the adoption of the technology, in the first place, because their decision to enter this degree would assume the acceptance of the continuous technology change as normal. Therefore, the difference in male and female perception of perceived usefulness, as hypothesized, was not confirmed in this thesis and with this sample of students.

Hypothesis four (H4) stated that female perceptions of Ease of Use will be more positive than males. Literature from many studies suggests that female perceptions of Ease of Use is higher than males (Kemp (2011; Venkatesh & Morris, 2000). These findings were confirmed by Ong and Lai (2006) and Venkatesh et al., (2003). Others suggested that perceived attributes of the system can differ (Gefen & Straub, 1997) and that the perception of the Perceived Usefulness of the system may be different but not the actual use of the system (Agarwal & Prasad, 1998). However the results in this thesis did not support the hypothesis and in fact found the opposite effect.

Female perception of Ease of Use was significantly less positive than that of males. Similar findings were stated in Dorman and Fraser (2009), who found that female students held a more positive perception towards the class environment, except for attitude toward computer use. The path diagram, in this study, shows a small effect of gender on task. After controlling for environmental factors (Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness) gender adds nothing significant to the explanation of Perceived Usefulness or Perceived Ease of Use. This finding reflects the importance of the ETAM in explaining these apparently contradictory results in the TAM literature.

Within the WIHIC literature, the perceptions of females toward computer use vary from a positive perception of computer use in the studies of Koul, Fisher, and Shaw (2010) and (Kemp, 2011) to less positive perception of computer use than males

(Dorman & Fraser, 2009) or no difference found (Rahmawati, Koul & Fisher, (2010) suggesting some contradictory results with regard to the gender.

Statistically significant but small effects have been found in this study, for females perceiving the Cohesiveness, Task Orientation and Cooperation scales of the classroom environment more positively than males. This result is similar to the findings of Margianti (2003) who found that females perceived their learning environment as more orderly and organized, task oriented, and with more cooperation, than did males. The fact that the endorsement of having more positive perception of Ease of Use for females is not confirmed and the effect of the contrary had been found (that males had higher endorsement of the Perceived Ease of Use) within the computing student sample, may suggest that this should be investigated further with different samples and different technologies.

Hypothesis five (H5) stated that older students will have more positive perceptions of Perceived Usefulness than younger students. The TAM literature suggests that older students have a stronger intention to use technology and more positive perceptions of Usefulness (Kemp, 2011; Venkatesh, Morris, Davis, & Davies, 2003; Venkatesh, Thong, & Xu, 2012). The WIHIC researchers Fraser and Treagust (1986) investigated the age factor and their results suggested that adult students perceived their classes as higher in satisfaction, involvement, individualisation and innovation. This study shows that no significance differences were found. This may suggest that age is relatively unimportant among computer students, perhaps because they were computing students and therefore already comfortable with the technology. Path analysis shows that, after controlling for all other WIHIC constructs, age has explained 6% of variance in Perceived Usefulness.

The same explanation applies to hypothesis six (H6) which states that older students will have a more positive Perception of Ease of Use than younger students. This hypothesis in this thesis has not been supported. The age has been categorized as under 21, 21-25, 26-30 and above 30. Perceived Ease of Use has been found to be higher in the groups for under 21 and for the 30 or more category but lower in the intermediate ones (26-30 and 21-25). Path analysis of the background

demographics, in order to identify the unique contribution of the background factors has found that the age made a significant contribution (while controlling for all the other factors) to the explanation of Perceived Ease of Use. Path analysis shows that, after controlling for all other WIHIC constructs, age has explained 5% of the variance in Perceived Ease of Use within the ETAM model.

Using the same explanation for hypothesis five, it is possible that among computing students age had no impact because these students were already comfortable with the technology and its use in learning. It may also indicate that younger generation which have been raised with technology changes, and adapt to the changes, find no difficulties in using yet another new technology. In particular, the attitude towards Ease of Use of the technology has been constantly developed with the younger generation and therefore the findings show no difference between the older and younger generations. They have had exposure to the new technologies all through their lives (Ipod, Ipad, smart phone, games console, etc.) and have constantly learned how to use it. It is worth noting that this may be further investigated as differences in motivation to use the technology, ranging from: older students' readiness to accept the technology because of their understanding of the usefulness of it, and motivation of younger students to use the same technology (possibly without understanding why) because it is just fun to do it, and in a way a fashionable thing to do.

Hypothesis seven (H7) stated that students with broader life experience will have more positive perceptions of Perceived Usefulness than students with narrower experience. Broader life experience has been defined in this thesis as how a student spent most of their time in the six months prior to starting the course. Four categories have been investigated. The results in this thesis suggest that there was no significant difference between working, studying, and working and studying groups but that significant difference was found between the "other" category and each of the remaining categories: working, studying, and working and studying. In each case, the "other" category had a lower endorsement of Perceived Usefulness. It was concluded that this hypothesis has been weakly confirmed in this thesis. Other researchers investigated experience (with technology) stating, that the more

experience users have with the technology the more willing they are to use it (Kemp, 2011). The findings of the TAM researchers: Agarwal and Prasad (1999) Venkatesh and Davis (2000), Venkatesh, Morris and Davies (2003), and Venkatesh, Thong and Xu (2012) support Kemp's findings.

Hypothesis seven has been weakly confirmed in this study as discussed above. Path analysis has been performed in order to identify the unique contribution of the personal constructs (background information) and has identified that the studying category has a unique and significant contribution (when controlling for all other influences) to the explanation of Perceived Usefulness in technology acceptance. It is worth noting that the influence of experience on technology acceptance in the educational environment needs further investigation, because its effects have been only partly captured in this thesis. The data need further exploration and collection of more specific data about students' life experiences is required. The findings from this thesis represent an indication that there is something worth exploring but it has not been captured and identified properly. This thesis has performed only exploratory investigation in this area and further study is needed.

Hypothesis eight (H8) stated that students with broader life experience will have less positive perceptions of Perceived Ease of Use than students with narrower experience. Findings in this thesis do not support this hypothesis. The first order of analysis indicated that the working and studying category had a higher mean than any other category. Further path analysis has identified that out of the four experience categories only the studying category made a significant unique contribution to the explanation of Perceived Ease of Use in technology acceptance, after controlling for all other influences. Some of the reasons for this could be that student sample came from computing students for whom the acceptance of the technology, and attitude toward the use may be higher than for students in other areas of study. As discussed previously, computing students are accustomed to technology change and have coping strategies to deal with changes. Further investigation into different life experiences and their effect on technology acceptance, as discussed previously, is needed.

Hypothesis nine (H9) stated that students with English as a first language will have a more positive perception of Perceived Ease of Use than students with another first language. The literature suggests (Soto-Rodriguez & Fraser, 2004) that students with limited English language proficiency perceived their learning environment less positively. The investigation in this thesis has been based on students reporting English language as being their first language or not. Contrary to the literature, no significant difference has been found in this study. Although those with English as a first language gave higher ratings of Perceived Ease of Use, the difference was not significant. Some of the explanations could be that the English language is official computing technology language for the world, and even students from other language backgrounds do come with some understanding of this technology and therefore this prior knowledge may minimise this difference. Further study is needed to identify whether this applies to students from the other area of study.

Hypothesis ten (H10) stated that students with non-English speaking background are likely to have a higher perception of Perceived Usefulness than those who have an English speaking background. The hypothesis has been supported in this study. It is suggested that students with a non-English speaking background found the software tool more useful than English speaking students. Some of the reasons could be that computers allow for a very individual learning space (man-to-machine) and there is no exposure of the language limitations per se, in the classroom to other students. It does allow the student to work individually, and therefore the difference in the language proficiency may have been minimised giving the foreign students the feeling of the usefulness of the tool. This tool has the means for allowing students to communicate with the lecturer by clicking the “need help” button, without asking for help loudly in the class. The other reason is that the tool had graphs as representation of student success and these graphs are the same shape in many languages and as such easier to understand by non-English speakers. Therefore, the use of this tool would be seen as more useful for the students with non-English background.

### 6.8.2. ETAM (MODEL)

The ETAM proposed in this thesis has set out the expected predictors of technology acceptance in an educational environment. The analysis carried out in this investigation has identified the main predictors among these expected predictors. It is the first attempt to systematically integrate environmental factors into previous TAM models. The factors were taken from the WIHIC model and incorporated into the ETAM as a new educational technology acceptance model.

This model has identified the benefits of the use of the technology in the educational environment through a Perceived Usefulness construct. It has also identified how difficult it is to use the technology via Perceived Ease of Use construct within the educational environment.

The objective of the ETAM developed and implemented in this thesis was to investigate the usefulness of this model within the educational environment. This has been achieved and the usefulness of the ETAM model has been in identifying the WIHIC constructs which had the main influence on technology acceptance in the educational environment. Task Orientation and Prior Experience were the main factors identified by the ETAM as being the main predictors of technology acceptance within the educational environment. In the final ETAM path diagram Teacher Support has fallen below significance and is not on the diagram. There is an overlap between students' perception of Teacher Support and students' first language. Task Orientation has been identified as the most important predictor of Perceived Usefulness. It explains 15% of the variance in Perceived Usefulness of the technology acceptance. Whether or not students were studying was the next important predictor. It explains 3% of the variance in Perceived Usefulness of the technology acceptance. Task Orientation has been identified as the most important predictor of Ease of Use of technology. It explains 11% of the variance in Ease of Use of the technology acceptance. The student experience (classified as studying, working, studying and working, and others) has been identified as the second predictor of Ease of Use of the technology. Whether or not students were studying explained 5% of the variance in Perceived Ease of Use. The definition of the

experience may vary from study to study and most of the studies defined the experience as familiarity with the technology. In this thesis the experience has been identified as the time prior to the study in which students were: studying, or working, or studying and working, or other.

The fact that the model has established that Task Orientation explains on its own 15% of the variance in Perceived Usefulness out of 25% of the variance in Perceived Usefulness for all WIHIC variables (while controlling for all other WIHIC constructs), is a major finding. Another major finding is that Task Orientation also explains on its own 11% of the variance in Perceived Ease of Use (while controlling for all other WIHIC constructs) out of 19% of the variance in Perceived Ease of Use for all WIHIC constructs.

The ETAM has identified that age explains 13% of the variance in Equity (while controlling for all other WIHIC constructs) and 3% of the variance in Cooperation. It explains 20% of the variance in Task Orientation and 10% of the variance in Teacher Support (while controlling for all other WIHIC constructs). It also explains 5% of the variance in students' Involvement and 3% of the variance in students' Investigation when controlling for all other WIHIC constructs. This model shows that age explains 7% of the variance in studying and explains 10% of the variance in working while controlling for all the other constructs.

The model has established that gender explains 3% of the variance in Cooperation, 5% of the variance in Cohesiveness, and 2% of the variance in Task Orientation while controlling for all other factors.

It has also established that whether or not the student was studying prior to the course explains 7% of the variance in Cohesiveness, 3% of the variance in Involvement and 9% of the variance in Investigations, while controlling for all other WIHIC constructs.

This thesis has investigated the educational environment influence on technology acceptance and identified which of the WIHIC environmental constructs are the major predictors of this influence in technology acceptance. These predictors are

Task Orientation and whether or not the student was studying, prior to taking the course.

This model has incorporated educational constructs in identifying the perceptions of the students in technology acceptance. As such the model is not suitable for every situation. For example, the purpose of the banking system would be very different from the purpose of an educational system. The system, as designed in the current state, may however still be used, but additional constructs should be added to address the uniqueness of the situation in which it is implemented. The TAM has been developed over time and new and more comprehensive versions of the TAM (UTAUT, TAM3) should be tested for technology acceptance within the educational environment. The main limitation of the current ETAM is that it does not cover personal factors adequately and system factors not at all. These elements are not easy to generalise, because by their nature, they are specific to the situation and should be analysed on a case-by-case basis. Another construct which may be investigated is the historical construct defining the quality of the past experiences with the technology before. For example in the case of introducing new technology into the system people may have been attached to the old technology and may find the new one difficult to accept. On the other hand, they may hate the old technology, and may be happy to accept anything new in order to move from the old one they did not like.

## 6.9. CHAPTER SUMMARY

The chapter has presented an analysis of student perceptions of the ETAM used for technology acceptance within an educational environment. It relates to the following objective of the study from the students perspective only:

- To evaluate the effectiveness of the ETAM model from students' and lecturers' perspectives.

It also relates to the following two objectives:

- To investigate the influences of the educational environment on technology acceptance.
- To identify the main predictors for technology acceptance.

It has tested 22 hypotheses investigating all the WIHIC constructs (Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness) and the two main TAM's constructs (Perceived Usefulness and Perceived Ease of Use). In addition to the WIHIC and the TAM constructs, the following demographics were investigated as part of the ETAM model: prior experience, gender, age and whether or not the students have English as their first language. The broad approach to testing these hypotheses was correlational and first order correlations were investigated. To determine the unique contributions of each component, path analysis and multiple regressions were used. The instrument and the sample has been explained and described. The data have been screened and full discussions of the first order of the analysis and path analysis presented.

The ETAM developed and implemented in this thesis had an objective to investigate the concept of this model and its usefulness within the educational environment. The main objective was to investigate the usefulness of the ETAM in order to identify the main predictors of technology acceptance in an educational environment. This has been achieved and the usefulness of the model has been in identifying which of the WIHIC constructs had the main influence on technology acceptance in this environment. The following main factors have been identified by the ETAM as, being the main predictors of technology acceptance within the educational environment: Task Orientation and Prior Experience (Studying) to taking the course of study. The limitations of the model have been identified and briefly discussed.

## Chapter 7.

### CONCLUSION

#### 7.1. INTRODUCTION

Learning environment research, as well as research into technology acceptance, has an established research history over the last several decades. However, no researcher has identified a model able to investigate attitudes toward technology acceptance in an educational environment. This thesis investigated the influences of the educational environment on technology acceptance by including all WIHIC constructs (scales) in a new extension of the TAM model named the ETAM model. This model combines two major instruments (an educational environment instrument and a technology acceptance instrument) into one new instrument the ETAM (Educational Technology Acceptance Model). Many researchers have used a variant of the technology acceptance model to investigate the acceptance of specific technologies and tools in different environments, including educational settings. They included the basic TAM constructs with new additions, such as enjoyment or readiness, and reported their findings for their specific situations. The Technology Acceptance Model allowed for this variety of uses by being generic, and therefore applicable to any technology. Every researcher who used the TAM in an educational environment used two generic constructs: Perceived Usefulness and Perceived Ease of Use. In addition, they added some of the environment constructs which were applicable to their specific environment, but not all of them. As a result, the influence of the educational environment on technology acceptance has not been fully investigated. This thesis has addressed this incompleteness.

Section two of this chapter provides a summary of each of the preceding chapters. Section 7.3 summarises the main findings and their significance. Section 7.4 explains the main limitations of the study and possible future work. Section 7.5 presents concluding remarks.

## 7.2. SUMMARY OF THE THESIS

This thesis represents a unique investigation that combines two models from different research areas: educational environment (WIHIC) research; and technology acceptance (TAM) research. This thesis developed a new technology acceptance model (ETAM) to investigate attitudes toward technology acceptance in the educational environment.

There were four objectives for this study to:

1. investigate the influence of the educational environment on technology acceptance in the classroom;
2. identify the major classroom environment predictors for technology acceptance;
3. develop and implement a tool to identify these predictors; and
4. evaluate the effectiveness of the ETAM model. This is achieved by using it to evaluate technology acceptance from lecturer and student perspectives.

Chapter One identified the main goal of the study, namely, “The development and implementation of the Educational Technology Acceptance Model (ETAM)”. The chapter provided background and the rationale for the study.

Chapter Two presented the theoretical background of the Technology Acceptance Model (TAM), based on Davis’s original work. Section 2.1 presented the following motivational theories: the trait perspective, the social-cognitive perspective, the theory of reasoned action and theory of trying. Section 2.2 presented the Technology Acceptance Models: TAM, TAM2, Unified Theory of Acceptance, Use of Technology model (UTAUT), and TAM3. Section 2.3 presented a literature review of technology acceptance models. Section 2.4 reviewed technology acceptance models used in education.

Chapter Three presented a literature review of learning environment research. Section 3.2 focused on the historical background of educational environment research. Section 3.3 explored the development of learning environment instruments. In Section 3.4, the What Is Happening In this Classroom (WIHIC)

instrument was introduced and its use in learning environment research reviewed in section 3.5. Section 3.6 explored use of the WIHIC instrument in learning environment research. The chapter explored the historical development, results and importance of this research. The research has impacted on learning and teaching development and understanding in the last several decades. It has grown into a new discipline in its own right, and delivered many instruments used in research investigations. The most popular and widely used instrument to measure aspects of the educational environment is the *What Is Happening In this Classroom* (WIHIC). This instrument has been used and validated in many studies, and accepted as the most comprehensive instrument to investigate the impact of the classroom environment on learning and teaching. This instrument has been combined in this thesis with the TAM model to make the ETAM educational technology acceptance model, as a special case of the technology acceptance model, developed for the educational environment investigations.

Chapter Four described the development and the concept of the ETAM model fulfilling the objective –to develop and implement a tool to identify main predictors. Section 4.1 explained the conceptual ETAM model. Theoretical analysis of the ETAM model is described in Section 4.2. The section described the technology acceptance constructs, the environmental constructs, and personal factors (background information) and concluded with a list of ETAM hypotheses. Section 4.3 described the method used to test the hypotheses. In Section 4.4, the software tool Salsa used to evaluate the ETAM model is described. The objective of the development and implementation of the ETAM was to increase knowledge and understanding of the factors that influence technology acceptance in the classroom environment. The chapter stated the 22 hypotheses of the study and identified the methodologies by which these hypotheses were tested. The structure of the instrument, incorporating both technology acceptance scales and educational environment scales, has been briefly described. The questionnaire used was tailored for the specific situation in which it was used. The methodology, the instrument, the sample and ethical consideration have been explained. A theoretical analysis, based on the literature findings for the technology acceptance

constructs, environmental constructs and four demographic factors, was presented. The Salsa software used in validation of the model was briefly described. The chapter presented the ETAM model, which has fulfilled objective three - to develop a tool to investigate the impact of the environmental on technology acceptances. The ETAM model developed in this study consists of both environmental and technology acceptance constructs.

Chapter Five presented a qualitative evaluation of the ETAM model. It used the ETAM model to investigate the lecturers' perceptions of the software. Section 5.1 described the sample of lecturers, methodology of investigation, and the instrument. Section 5.2 explained the analysis. Section 5.2.1 presented the technology acceptance constructs (TAM): perceived usefulness and perceived ease of use. Section 5.2.2 described the environmental constructs (WIHIC) identified in the lecturer interviews. Section 5.2.3 presented the analysis of background demographics (age, gender, experience, and English as first language). Section 5.3 presented a discussion of the results.

The four lecturer interviews were qualitatively analysed using the ETAM analytical framework. The perception of the lecturers was evaluated by semi-structured interviews. The reason for choosing a qualitative methodology was its ability to capture the richness of the information and also to accommodate small numbers of participants. The analysis confirmed that the ETAM analytical framework was easy to use, from the researcher's point of the view. The analysis focussed on the usefulness and ease of use of the Salsa software used to evaluate the ETAM model. The technology acceptance of this software was investigated and the influences of the educational (WIHIC) constructs were identified. The analysis included both the lecturers' perspectives on the usefulness of the software, and also their perspective of the usefulness of the software for their students. The chapter validated the ETAM model from the lecturer perspective.

Chapter Six presented the students evaluation and perspective of the software, analysed through the framework of the ETAM model. The student perceptions of the technology in an educational classroom environment were evaluated with a

questionnaire. It has satisfied the requirements from the objective - to evaluate the effectiveness of the ETAM model from students' perspectives. Section 6.1 described the instrument, section 6.2 the sample, and section 6.3 the method of analysis. Section 6.4 described the screening of the data. Data screening included measurement hypotheses and differential item functioning by gender, by whether the student was in their first semester of study or not, by first language, by prior experience, and by age. Section 6.5 presented results. Section 6.6 described the second order of analysis performed by path analysis. The discussion is presented in Section 6.7 and includes discussion of the hypotheses and the ETAM model.

The chapter analysed student attitudes towards the software using the framework of the ETAM model. Twenty two hypotheses were tested, investigating all the WIHIC constructs (Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation and Student Cohesiveness) and the two main TAM constructs: Perceived Usefulness and Perceived Ease of Use. In addition to the WIHIC and the TAM constructs, the following demographics were investigated as part of the ETAM model: prior experience, gender, age and whether or not the students had English as their first language. The broad approach to testing these hypotheses was correlational and first order correlations were investigated. To determine the unique contributions of each component, path analysis and multiple regressions were used. The instrument and the sample has been explained and described. The data have been screened and discussion of the first order of the analysis and path analysis was presented. This chapter has validated the ETAM model from the student's perspective.

The ETAM developed and implemented in this thesis was used to investigate its usefulness as a conceptual research framework within the educational environment. One objective was to identify the main predictors of technology acceptance in an educational environment. This has been achieved and the usefulness of the model has been in identifying which of the WIHIC constructs had the main influence on the technology acceptance in this environment. The following main predictors have been identified by the ETAM model as: Task

Orientation, and Prior Experience (Studying) to taking the course of study. The limitations of the model have been identified and briefly discussed.

### **7.3. FINDINGS AND SIGNIFICANCE OF THE STUDY**

The findings of this thesis can be divided into two areas: findings in regards to the WIHIC constructs, and findings that identified the unique contribution of the WIHIC constructs and demographic constructs in technology acceptance within educational environments.

#### *Positive relationship between the WIHIC constructs and the TAM constructs*

The first findings of this study came from the first order of the analysis identifying the relationship between the WIHIC constructs (Task Orientation, Teacher Support, Investigation, Involvement, Equity, Cooperation, and Student Cohesiveness) and the TAM constructs (Perceived Usefulness and Perceived Ease of Use). Hypotheses H1 (a-g) and H2 (a-g) stated that each of the WIHIC constructs would be positively associated with Perceived Usefulness (H1) and with Perceived Ease of Use (H2). These hypotheses were supported and the findings align with those from the literature review. All of the WIHIC constructs have a positive correlation with the TAM Perceived Usefulness and Perceived Ease of Use. These hypotheses were tested by investigating the first order of the correlations between the scales. First the calculation of the magnitude and significance of the Pearson correlation between the measures was performed. When the underlying assumption of the Pearson coefficient was in doubt, a non-parametric approach was used. Normality test was performed by a Jarque-Bera test (1987). Spearman rank correlation test, supported by a strict monotonic association test (Gamma test), was used when data failed the Jarque-Bera test. The details of the analysis are provided in section 6.5 of the thesis.

### *Contribution of demographic constructs and the WIHIC constructs*

The contribution of demographic factors on the WIHIC constructs has been identified for gender, age and studying factors. Gender explained 2% of the variance in Task Orientation, 3% of the variance in Cooperation, and 5% of the variance in Cohesiveness. Age on the other hand explained 13% of the variance in Equity, 20% of the variance in Task Orientation, and 10% of the variance in Teacher Support, with smaller contributions for Involvement, Investigation and Cooperation. Studying explained 9% of the variance in Investigation, 7% of the variance in Cohesiveness and smaller contributions for Involvement and Teacher Support. This analysis identified age and studying as the main predictors for the WIHIC constructs.

### *Contribution of demographic constructs and unique contribution of age studying (experience category)*

The contribution of demographic constructs on the technology acceptance constructs perceived was identified in two ways: by the first order correlational analysis, and by the unique contributions of each by the path analysis. This study investigated the following demographic constructs: age, gender, experience six months prior to study, and whether English is a student's first language or not. The following findings were obtained for age: the hypothesis that males' perception of Perceived Usefulness would be more positive than females was not supported. Similarly, the hypothesis that females' perception of Ease of Use would be more positive than males was not supported either. Indeed, perceptions of Ease of Use were significantly higher amongst males.

The following findings were obtained for age: it was not supported that older students would have more positive perception of Perceived Usefulness or Perceived Ease of Use.

In regards to experience, it was found that the hypothesis that students with broader experience would have more positive perception of Perceived Usefulness was weakly supported. The endorsement followed the hypothesised order but it

was weak. It was also found that the hypothesis that students with broader experience would have less positive perception of Ease of Use was rejected.

With regards to the English language, it was found that students with English as their first language did not have a more positive perception of Ease of Use than students with another first language. The hypothesis that students with a first language other than English would have higher perception of Usefulness than those with English as a first language was supported. The results were discussed in Section 6.5.

Path analysis identified the unique contribution of the demographic factors in this study. The results suggested that age and studying (one of the Experience Categories) explained respectively 6% and 5% of the variance in Perceived Usefulness, while controlling for all the other influences. They also explained 5% (age) and 6% (studying) of variance in Perceived Ease of Use, while controlling for all the other influences. The results were discussed in section 6.6. The unique contribution of demographic factors is a significant finding in this study. This is important because practical considerations often mean that a full instrument cannot be administered. Identifying the main predictors allows a shortened instrument to be used, while still retaining most of the relevant information.

#### *Unique contribution of the WIHIC constructs in prediction of perceived usefulness and perceived ease of use findings*

The analysis performed with the WIHIC constructs and the TAM constructs has revealed the most important WIHIC predictors of technology acceptance. This was a very significant finding which identified first the unique contribution of each WIHIC construct towards Perceived Usefulness and Perceived Ease of Use, and second which of these were major predictors. This was achieved by path analysis. A process of stepwise predictor elimination was used to eliminate all non-significant predictors, thus retaining only those that made a significant contribution. The study has identified the main predictors among WIHIC constructs, while controlling for other influences, of Perceived Usefulness and Perceived Ease of Use. These main predictors were Teacher Support and Task Orientation. Together, they explained

20% of the variance of Perceived Usefulness and 16% of the variance of Perceived Ease of Use. The significance of these findings lies in the identification of the unique contribution of each of the WIHIC constructs and, in particular, identifying the major predictors of technology acceptance. This is very significant for technology acceptance in the educational environment.

*Unique contribution of the WIHIC constructs in prediction of Perceived Usefulness and Perceived Ease of Use findings within the ETAM model*

The ETAM model has identified the main educational environment predictors of technology acceptance. This model includes the WIHIC constructs, the TAM constructs (Perceived Usefulness and Perceived Ease of Use) and demographic constructs (age, gender, experience six months before taking the course, and whether or not English language is the first language). The major predictors of Perceived Usefulness, and Perceived Ease of Use have been identified as Task Orientation and Studying (one of the Experience categories). After controlling for other influences, Task Orientation explained 15% of the variance of Perceived Usefulness, out of 20% in total, and explained 11% of the variance of Perceived Ease of Use, out of 18% in total. It is also worth noting that age explained 20% of the variance of Task Orientation, out of 24% in total. The finding that Task Orientation and Studying were the two most important predictors for technology acceptance is a significant and major contribution of this thesis. It is important for two reasons. First, it will allow practitioners to use a shorter form of the WIHIC questionnaire for technology acceptance studies, while still retaining most of the relevant information. Moreover, since Age was a significant predictor of Task Orientation, it is important for a researcher to match the age profile of participants in a study with the target population for the technology. Second, it informs practitioners who are trying to implement new technology in the classroom on which constructs to focus in order to foster adoption.

### *ETAM model evaluation*

The ETAM model, designed in this thesis, has been used to evaluate lecturer and student perspectives. The evaluation of the lecturer perspective was completed by qualitatively analysing the lecturers' semi-structured interviews. The interviews had only two planned topics to discuss and the rest of the interview was allowed to evolve from these topics. The interviews were analysed by using thematic analysis and the ETAM as an analytical framework. The analyses confirmed that this framework was very useful in identifying many educational environment constructs in the interviews, in addition to the technology acceptance constructs that were originally scheduled as the topics in the interviews.

The evaluation by the students was quantitative in its nature and involved the administration of the tailored questionnaire which incorporated the WIHIC and the TAM scales as well as specific scales for the software used in the evaluation. The analysis included correlational analysis and path analysis.

### ***Significance of the study***

The main significance of this study is in the development of the ETAM that can be used as an analytical framework for the analysis of technology acceptance attitudes in an educational setting.

### *ETAM model development*

This study has developed a unique model for the investigation of technology acceptance in an educational setting. The ETAM is based on the two established models: the technology acceptance model TAM, and the educational environment model WIHIC. There are two reasons for combining the TAM and WIHIC. First, both of these instruments are generic and can be used for any setting, technology, or user types. Second, both of these instruments have antecedents in motivational theory and, as such, were logical choices to be combined. This model is designed to be a generic model for the investigation of acceptance of any technology in educational settings. It is neither tool nor software specific and is designed to be used with any technology. It is designed to be used by any educational participant

(teachers or students), and in any classroom environment (primary, secondary or tertiary).

This research provides a better understanding of technology acceptance in an educational environment. It informs the understanding of the specific and unique influences of the environmental constructs on technology acceptance attitude. This is the first technology acceptance model designed for use in a classroom environment, and the first one that incorporates all environmental constructs from the most significant instrument used in the educational environment investigations, the WIHIC.

The study implemented this model in a specific tertiary educational environment. The evaluation of this model from the students' and the lecturers' perspective added a new understanding of technology acceptance in the tertiary settings.

#### *Main environmental predictors of technology acceptance by ETAM model*

The ETAM's major predictors of Perceived Usefulness, and Perceived Ease of Use have been identified as Task Orientation and Studying (one of the Experience categories).

#### *Main demographic predictors*

The main ETAM demographic predictors were identified as age and studying. Age and Studying explained 11% of the variance in Perceived Usefulness, and 5% and 6% respectively in Perceived Ease of Use.

#### *Unique contribution of the WIHIC constructs*

After controlling for other influences, the main predictors, among WIHIC constructs, of the technology acceptance constructs, Perceived Usefulness and Perceived Ease of Use, were identified as: Teacher Support and Task Orientation. The importance of Teacher Support has been discussed by many authors and this finding is aligned with the literature findings as one of the most important predictors of technology use in the environmental settings. Task Orientation has been also identified in the literature as an important predictor of student engagement in the process of

learning, which, in turn, leads to a positive attitude to the environment and the technology.

#### **7.4. LIMITATIONS AND FUTURE WORK**

Limitations of the study and suggestions for future work are described in this section. The limitations are discussed in regards to: the implementation environment, the type of the TAM model used, the type of software introduced in the environment, the user types involved, the personal factors used, and the system factors used.

##### *Limitations in regards to the implementation environment*

The first limitation concerns the generalizability of this study, which was conducted in a tertiary institution. These findings may not apply to other levels of education (primary and secondary). In order to clarify the applicability of this findings future research of ETAM investigation in secondary and primary education should be conducted.

##### *Limitations in regards to the TAM and WIHIC models used*

The second limitation is in regards to the basic models of TAM which were used to create the ETAM model. The findings may not apply to new models of TAM such as UTAUT, UTAUT2, and TAM3. The WIHIC educational environment instrument has also been extended for different technologies and new additional constructs have been added to create new models as WOBLEI, TROFLEI etc. Future work is required to incorporate new models of WIHIC and TAM into an extension of the ETAM model and to investigate further.

##### *Limitations in regards to the type of software introduced in the environment*

The third limitation is in regards to the software (the Salsa software) used to validate the model. This software is only one of many types of educational software that are used to aid learning and to help monitoring of the learning in the classroom

environment. Future research is needed with different types of software to validate the findings in order to explore the generalizability of this model. Since the ETAM model is based on generic models, application in a specific situation may not be suitable, and may require the addition of more constructs relevant for the specific situation.

*Limitation in regards to the user types used*

This study used students enrolled in a computing degree course in a tertiary setting so the result may vary if the study is repeated with a different sample. More research is needed to include other samples from different educational settings to enable generalisation of the results.

*Limitations in regards to personal and system factors*

This study has not included many personal and system factors already used in studies in both areas WIHIC (active learning, reflective thinking, autonomy/independence) and TAM (social ability, readiness, enjoyment, computer efficacy, self-efficacy, trust, confidence as well as job relevance, experience, and voluntariness, trust usability, and task type). Both of these areas are very specific and therefore difficult to generalise and will remain as such for every individual situation. Personal factors as well as System factors should be included in extensions of the ETAM model and investigated in future work.

*Lack of qualitative data from students*

This study has included only quantitative data from students. This lack of qualitative data limited this study because combined qualitative and quantitative data would allow for greater credibility since these data are collected using a range of data collection methods.

*Bias from the relationship of the researcher and the subjects of the study*

I had a relationship with the lecturers in this study because they were my colleagues in the department and therefore they were more willing to allow me access to the classes. As a consequence, bias might have been introduced in the

choice of which classes were selected for this study. As a researcher, I had no other relationship with the students in these classes. To address the student power relationship with their lecturer I administered the questionnaire myself.

#### *Data Management*

Data were entered by me into specialised software used for analysis and therefore the inaccuracies were minimized. Data interpretation was enhanced by data screening using the 13 measurement hypotheses.

#### *Generalisation of the study*

The connection between TAM and WIHIC has been carried out at a basic level. Further research is needed to investigate special tools such WOBLEI and TROFLEI or MOBLEI, combined with newer versions of TAM (TAM2, TAM3, UTAUT) models to investigate further. The author has used the basic and original versions of both models in order to establish and test the general concept of the model. Any other combination of different versions of one or both of these instruments is a task for future work.

### **7.5. CONCLUDING REMARKS**

Research into educational environments influences the classrooms and the teaching of many lecturers at all levels. The importance of this environmental research and its effects has changed our approach to teaching and managing our classes. Technology, as well, has influenced, and is continuously influencing, our classrooms on an everyday basis. Our new generations of students are coming with more and more gadgets and find them easy to use. The combination of both of these influences, the educational environment and the technologies, are equally important. It is my humble hope that this research may be a small step in our gaining a better understanding of their interrelationship.

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Every reasonable effort has been made to acknowledge the owners of copyright material. I would be pleased to hear from any copyright owner who has been omitted or incorrectly acknowledged.

## APPENDIX A

### Student Evaluation of Salsa computer software

*This questionnaire should take about 15 minutes to complete*

This questionnaire has been designed to allow you to describe, in a systematic way, your experience with the Salsa software used in this course. The technique involves asking you a substantial number of questions which overlap to some extent to provide good overall coverage of different ways of studying. Please respond truthfully, so that your answers will accurately describe your actual experience with Salsa and work your way through the questionnaire quite quickly.

#### A. Usefulness of Salsa

Based on your experience in this course, please indicate how useful you have found each of the Salsa features set out below.

		Not at all useful	Little use	Some use	Fairly useful	Very useful
1.	The graph (time) showing the time you spent					
2.	The graph (status) showing your mastery of each week's material					
3.	The graph (progress) showing your learning progress.					
4.	Seeing progress bars of your learning progress					
5.	Showing success and excellence regions on the learning progress graph.					
6.	Seeing progress bars on your time spent					
7.	Showing the expected contact and self-directed hours on the time graph.					
8.	Seeing the summary of time, week by week.					
9.	Seeing a checklist of the course activities					
10.	Seeing a checklist of the expected learning outcomes					
11.	Seeing the current status you have recorded for activities					
12.	Seeing the current status you have recorded for learning outcomes					
13.	Being able to look forward to the planned activities and items in future weeks.					

14.	Being able to ask the tutor for help on an item by clicking in the help column					
15.	Being able to ask for help without other students being aware of it.					
16.	Being able to have exclusive one-to-one time discussing learning with the tutor					

### B. Ease of use and understanding

How easy or difficult did you find the following?

		Very Difficult	Difficult	OK	Easy	Very easy
1.	Entering the time you spent each week					
2.	Learning to use the software.					
3.	Learning to enter the weekly reports.					
4.	Learning to use the graphs.					
5.	Deciding whether to say mastered or need time					
6.	Understanding the graphs.					
7.	Learning how to ask for help.					
8.	Understanding what is meant by an activity.					
9.	Understanding what is meant by a mastery item.					
10.	Learning how to interpret the graphs.					
11.	Understanding the purpose of Salsa					

### C. Describe how you feel today about this class

Identify how often the following statements apply to your experience in this class.

		Never or almost never	Rarely	Sometimes	Often	Always or almost always
1.	I make friends among students in this class.					
2.	I know other students in this class.					
3.	I am friendly to members of this class.					
4.	Members of the class are my friends.					
5.	I work well with other class members.					
6.	I help other class members who are having trouble with their work.					
7.	Students in this class like me.					
8.	In this class, I get help from other students.					

9.	The teacher takes a personal interest in me.					
10.	The teacher goes out of his/her way to help me.					
11.	The teacher considers my feelings.					
12.	The teacher helps me when I have trouble with work.					
13.	The teacher talks with me.					
14.	The teacher is interested in my problems.					
15.	The teacher moves about the class to talk with me.					
16.	The teacher's questions help me to understand.					
17.	I discuss ideas in this class.					
18.	I give my opinion during class discussions.					
19.	The teacher asks me questions.					
20.	My ideas and suggestions are used during classroom discussions.					
21.	I ask the teacher questions.					
22.	I explain my ideas to other students.					
23.	Students discuss with me how to go about solving problems.					
24.	I am asked to explain how I solve problems.					
25.	I carry out investigations to test my ideas.					
26.	I am asked to think about the evidence for my statements.					
27.	I carry out investigations to answer questions coming from discussions.					
28.	I explain the meaning of statements, diagrams, and graphs.					
29.	I carry out investigations to answer questions that puzzle me.					
30.	I carry out investigations to answer teacher's questions.					
31.	I find out answers to questions by doing investigations.					
32.	I solve problems by using information obtained from my own investigations.					
33.	Getting a certain amount of work done is important to me.					
34.	I do as much as I set out to do.					
35.	I know the goals for this class.					
36.	I am ready to start class on time.					
37.	I know what I am trying to accomplish in this class.					
38.	I pay attention during this class.					
39.	I try to understand the work in the class.					
40.	I know how much work I have to do.					
41.	I cooperate with other students when doing assignments.					

42.	I share my books and resources with other students when doing assignments.					
43.	When I work in groups in this class, there is teamwork.					
44.	I work with other students on projects in this class.					
45.	I learn from other students in this class.					
46.	I work with other students on class activities.					
47.	I cooperate with other students on class activities.					
48.	Students work with me to achieve class goals.					
49.	The teacher gives as much attention to my questions as to other students' questions.					
50.	I get the same amount of help from the teacher as do other students.					
51.	I have the same amount of say in the class as other students do.					
52.	I am treated the same as other students in this class.					
53.	I receive the same encouragement from the teacher as other students do.					
54.	I get the same opportunity to contribute to class discussions as other students.					
55.	My work receives as much praise as other students' work.					
56.	I get the same opportunity to answer questions as other students.					

#### D. Background information

*Please circle as appropriate*

1. Your age on your last birthday                      Under 21    21-25    26-30    Over 30
  
2. Gender    Male        Female
  
3. Is this your first semester here?                      Yes                  No
  
4. Is English your first language?                      Yes                  No

5. How did you spend most of your time in the six months prior to starting this course? Working Studying Other

### **E. Comments**

*Please feel free to add any comments you feel might be useful to us*

### **F. Consent to access course marks and Salsa data**

*Access to your course marks and Salsa data will let us look at the relationship between your responses to this questionnaire and your results in the course. We will not access your course marks without your consent, but giving your consent will mean that your responses are no longer anonymous.*

If you would like your responses to remain anonymous, please remove and discard the attached consent form before returning this questionnaire.

If you are happy for us to access your course marks, please complete and sign the attached consent form and leave it attached to this questionnaire; we will allocate a code number for cross-reference purposes and file the consent separately.

***Thank you very much for spending time completing this questionnaire; it is much appreciated.***

## APPENDIX B

### Response from Professor Venkatesh to email requesting permission to use his figures of TAM models in this thesis

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#### RE: Permission to reprint your models in my PhD

Tuesday, 30 October 2012

12:47 p.m.

Subject	<b>RE: Permission to reprint your models in my PhD</b>
From	<a href="#">Viswanath Venkatesh</a>
To	Dobriila Lopez
Sent	Friday, 5 October 2012 11:22 a.m.

Thanks for your interest.

You have my permission. You may want to look at the more recent UTAUT2 that was published in MIS Quarterly in June 2012. Other papers that maybe of interest are available through:

<http://vvenkatesh.com/Downloads/Papers/fulltext/downloadpapers.htm>

You may also find my book, which is available for a significant student discount, to be helpful: <http://vvenkatesh.com/book>

Sincerely,

Viswanath Venkatesh

Distinguished Professor and George and Boyce Billingsley Chair in Information Systems

Walton College of Business

University of Arkansas

Fayetteville, AR 72701

Phone: 479-575-3869; Fax: 479-575-3689

Email: [vvenkatesh@vvenkatesh.us](mailto:vvenkatesh@vvenkatesh.us)

Website: <http://vvenkatesh.com>

IS Research Rankings Website: <http://vvenkatesh.com/ISRanking>