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Information and Communication Technology Acceptance Model for Empirically Testing Primary Science Teachers' Use of ICT in Kuwait

A Dissertation submitted by

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Abstract

Research has indicated that teachers' perceptions have an important influence on their use of Information and Communication Technology (ICT) in teaching. The main aim of this study was to develop and assess a theoretical model that can predict and explain female primary school science teachers' use of ICT by focusing on a range of psychosocial factors. To achieve this, the technology acceptance model (TAM) (Davis, 1989) was adapted. TAM is considered to be a suitable theoretical framework on which to base the study because of its unique approach to examining behaviour towards the use of technology and its wider applicability in behavioural studies. There are two key predictors in TAM, perceived usefulness and perceived ease of use. Further, the model also has a variable that is known as behavioural intention, which is closely linked to actual behaviour. In the current study certain extensions to the model were added to explain variance not predicted by the standard TAM variables of usefulness and ease of use. The proposed ICT Acceptance model was developed by adding the constructs perceived external barriers, self-efficacy of using ICT in teaching, and subjective norms to the original TAM, to assess its performance in predicting teachers' use of ICT in teaching.

Using a survey questionnaire, data were collected from a total of 500 Kuwaiti female primary science teachers. Structural equation modelling (SEM) using AMOS 21.0 software was employed as the statistical analytic technique to assess the proposed model (ICTAM). The survey results revealed that the proposed model demonstrated a good fit. Interviews were also conducted with 21 female science teachers which provided greater details in more depth about why teachers make an effort to use ICT even if it is not provided by the schools. The study revealed important information about factors that affect teachers' acceptance of ICT in teaching science. It identified which barriers have to be removed in order to encourage science teachers to use ICT in their teaching. Moreover, suggestions were made for successful implementation of ICT in teaching science.

Certification of Dissertation

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

30 July 2014

Signature of Candidate — Date

ENDORSEMENT

30 July 2014

Signature of Principal Supervisor — Date

Signature of Associate Supervisor — Date

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Chapter 1: Introduction

Research about science teachers is increasingly recognizing the importance of Information and Communication Technology (ICT) to support science in the classroom (Alayyar, Fisser & Voogt, 2012; Dawson, 2008; Williams et al., 2013). The use of ICT in the classroom is expected to have a great impact on the quality of the teaching experience (Aldunate & Nussbaum, 2013; Umar & Yusoff, 2014; Summak, Samancioglu, & Baglibel, 2010; Ward & Parr, 2010). Deriving the benefits of ICT has given rise to the concept of ICT integration into the classroom. In other words, the idea of using of ICT in the classroom has shifted from using it as a supportive tool to an instructional tool that is integrated into the curriculum to achieve technology-enabled learning (Ertmer & Ottenbreit-Leftwich, 2013).

There is, therefore, a need to explore how teachers use ICT in the classroom, identify the factors that affect science teachers' use of ICT in teaching, and examine the causal relationship between beliefs, attitudes, and perceived external barriers.

This thesis is exploratory and reports on an empirical investigation for the identification of the factors that can influence the integration of ICT in teaching in Kuwait primary schools. Kuwait primary schools ideally suit the purpose of this study. Kuwait realizes that it is an oil producing country and that the oil is a non-renewable resource. Because of that, the country endeavours to develop other income resources to grow the economy. From this standpoint, studying primary science teachers is one of the priorities of Kuwait to help promote and develop the country. Science is a subject that is important for Kuwait as it can create a new generation of innovators who can assist to raise the income level of the country. Therefore, Kuwait endeavours to make sure that science teachers are using the best teaching approaches, which in turn enhances student learning. This is a study of science teachers' perceptions and the factors that affect their development to find solutions for overcoming barriers to achieving educational excellence.

The purpose of this chapter is to present an outline of the study and an introduction for the chapters that follow. Section 1.1 provides a discussion on the background of the study. The use of ICT is addressed in Section 1.2. The research problem is then discussed in Section 1.3. Section 1.4 discusses the significance of the study. The purpose of the study is discussed in Section 1.5. Section 1.6 provides a discussion about the theoretical framework, aims, and research questions. The research methodology is explained in Section 1.7. The terminology of ICT is provided in Section 1.8. Finally, Section 1.9 reviews the thesis structure providing a very brief explanation of the seven chapters of this thesis.

1.1 Background Information

Kuwait is one of the Gulf States members. It is located at the north western corner of the Arabian Gulf bordered by the Kingdom of Saudi Arabia in the south and south west, and the Arabian Gulf in the east.

Kuwait has a land area of 17,818 sq km (6200 square miles), with a population of 2.6 million, of whom 45% are Kuwaiti while 55% come from different countries (Katzman, 2008). In terms of religion, the population is divided into Muslims 85%, and other different religions 15% (Katzman, 2008). Kuwait is divided into six educational governorates: Al-Ahmadi, Al-Asimah, Al-Farwaniyah, Al-Jahra, Hawalli, and Mubarak Al-Kabeer.

The Education system in Kuwait has been improved over time to accommodate the political, economic, and cultural changes. Early in the 18th Century, students were taught some reading, writing and arithmetic in Al-katatib which were located in mosques. There were few of these schools, which were funded by wealthy citizens. In 1911 the government built the first school Al-Mbarakiah that enrolled 300 students and by 1945 they had opened 17 schools (Aldafiri, 2006; Mohammad, 2008). With the increase of oil profits, the government invested in the budget for education, which caused increasing student numbers to a total enrolment of 45,000 by 1960. Currently, education in Kuwait has become more developed, and follows international standards.

The Kuwait educational system was divided into three grade spans: grade 1-4(primary stage), grade 5-8 (intermediate stage), and 9-12 (secondary stage) (Kuwait Information, 2009). However, the educational system has been changed in 2004-4005 from four years in the primary stage into five years which has led to: grade 1-5 (primary stage), 6-9 (intermediate stage), and 10-12 (secondary stage) (IBE, 2010). In all stages, boys and girls are separated in different schools. In conjunction with these changes, the Ministry of education has made the decision of assigning only female teachers to teach in primary schools. However, recently the Ministry of Education established two to three primary schools that are taught by male teachers in each district, while the rest of the primary schools a taught by female teachers. The social and religious cultures are responsible for this change. This change stipulates that students who fail many times and become 12 years old are sent to these schools (Ministry of Education 2013).

Computer use in schools was implemented in secondary schools in 1987, in intermediate schools in 1993, and in primary schools in 2001 by providing computers as well as computer labs within each school (Ministry of Education, 2007). Compatibly with these years, computer studies were also incorporated into the school's curriculum. A training program for teachers to obtain the international computer driving licence (ICDL) was launched in 2002. This training program is funded by the government for all pre-service and in-service teachers. This program is considered to improve teachers' ICT proficiency by teaching them all the basic IT skills that trace UNESCO's guidelines (Ministry of Education, 2007). MoE has encouraged all teachers to integrate ICT into all subjects due to its importance to enhance the learning and teaching process. MoE has sought to make a real change in the education system to fit the requirements of the 21st century. MoE offers workshops throughout the year to enhance the functional performance of teachers. It also encourages schools to conduct educational programs and workshops; and it is keen that there is exchange of visits between schools as well as teachers within the school building because of its importance to improve teachers' performance. Further, it is keen that teachers and administrators have a shared vision regarding educational issues.

One of the development milestones in Kuwait is using ICT, which has become a cultural feature in both private and public sectors. The use of the Internet in Kuwait began in 1992 and this use increased to reach 900,000 users in 2008 (IWS, 2009). Computers and Internet access have found their way in educational institutions. Furthermore, ICT has become a priority in Kuwaiti schools' development plans.

1.2 The use of Information and Communication Technology in Education in Kuwait

The use of ICT in the educational sector has become essential in all countries that try to follow contemporary methods to improve their educational systems. In Kuwait, despite the use of ICT in education being new and still in its developmental stages, the education system has endeavoured to improve the way of using ICT in education not only to develop the ICT skills but also to enhance the learning and teaching process. Kuwait tries always to improve the quality of teaching and learning. For example, it has provided ICTs in all Kuwaiti schools. It also endeavours to be up to date regarding the latest research studies that help teachers to efficiently and effectively improve their teaching (Ministry of Education, 2007).

Moreover, the Kuwaiti government believes that implementing ICT in education improves the quality of the education delivery (Ministry of Education, 2007). Therefore, the government has committed to a comprehensive program of rapid expansion of use of ICT within schools in order to transform the education system and improve the lives of our people. In order to do that, it has developed a strategy to use ICT in education, starting in 2002. The main goal of this strategy was to bridge the gap between general education, and personal and public uses of ICT in various scientific sectors (Ministry of Education, 2003). The strategy comprised multiple stages, some of which have been launched in schools. The first stage was providing schools with computers as well as computer laboratories. The second stage was introducing a computer studies subject in the curriculum for all schools. The third stage was equipping all schools with Internet and network multimedia computer systems in computer laboratories. The fourth stage was providing in-service training in the use of ICT in education for all teachers (Ministry of Education, 2007).

1.3 Research problem

Internationally it has been reported that there is limited use of ICT in the classroom (Ertmer & Ottenbreit, 2013; Kafyulilo & Keengwe, 2013). However, there are numerous research studies examined the factors that influence the use of ICT in the classroom (Agyei & Voogt, 2010; Liu, 2011; Phua, wong, & Abu, 2012). Most of these research findings show that the factors such as technology resources (Martinovic & Zhang, 2012), support (Mueller, 2008), beliefs (Teo, 2013), and attitudes (Badri, Al Rashedi, & Mohaidat, 2013) have a limiting effect on the use of ICT in the classroom.

These factors not only affect the use of ICT in general, but are also interrelated as each might affect the other. However, studies that explored these interrelationships between those factors are limited (Nair & Das, 2012). For instance, Teo (2010b) studied the relationship between perceived usefulness, perceived ease of use, subjective norms, facilitating conditions, and attitude toward behaviour. He concluded that there were significant relationships between those variables. Research has recommended that “in order to obtain a successful curriculum reform, it is required to understand teachers’ beliefs and their influence on the implementation of innovations” (Barak, 2014, p. 3). Also, more research is needed for studying causal relationships between different variables (Karaca, Can, & Yildirm, 2013; Teo, 2011).

In Kuwait, the Ministry of Education (MoE) has introduced ICT into the educational system in 2002 (MoE, 2007). However, there were no clear strategies or guidelines for teachers to integrate ICT into the teaching and learning process. Since the decision was taken so many years back, many schools in Kuwait seem to have not included ICT as part of their school curriculum. Traditional teaching methods with teacher-centred approaches are still predominant (Alayyar, 2012; Alkharang & Ghinea, 2013), and the consequence is that the quality of the education at primary level will go down and Kuwait will not be able to compete with the rest of the world information technology.

Kuwait participated in the *trends in International mathematical and science study* (TIMSS) in 2011; average score in science was 347. However, the percentage of students with achievement that was too low for estimation exceeded 15% but did not exceed 25% which indicates that there are reservations about the reliability of the data. The TIMSS data also indicated the importance of the current study, because no data was available from the TIMSS 2011 report on computer software for science instruction in Kuwait. The use of ICT for lesson is compared to other countries such as New Zealand (85%) is lower than half (34%).

Investments in technology are launched by countries to improve learning and teaching. The way of implementing the curriculum can be improved and facilitated by using computers and ICT in the science classroom such as providing Internet to explore concepts in-depth, trigger enthusiasm for learning, and access to information sources (TIMSS, 2011). Tamim, Bernard, Borokhovski, Abrami, and Schmidt (2011) conducted a meta-analysis study and found that use of ICT in the classroom has a significant positive effect on students' achievement at all grads and in all subjects. The TIMSS 2011 results showed that internationally the average of the students who had computers available during science classroom was 47%. Moreover, the students with computers available during the lessons had slightly higher achievement in science than students without computers available.

This study is important because it will bridge the knowledge gap that exists concerning the factors that affect primary science teachers' use of ICT in teaching in Kuwait. It will particularly investigate the factors that influence teachers' use of ICT in teaching and the causal relationship between those variables.

1.4 Significance of the research

Kuwait has invested to make ICT available in schools. However, its use to enhance the learning and teaching process is limited. This study explores the perceptions of science teachers about ICT acceptance. It examines relationships among variables associated with factors that influence ICT acceptance. It endeavours to identify which barriers have to be managed in order to stimulate science teachers to use ICT in their teaching. The decision to study the factors influencing Kuwaiti primary science teachers' use of ICT was based on the shortage of studies that focus on the factors influencing Kuwaiti primary science teachers' use of ICT. Therefore, the results of this study may help MoE, administrative and educational bodies to find the solutions for the problems that hinder teachers from using ICT in teaching.

This study extends the applicability of Technology Acceptance Model (TAM) to studies of ICT acceptance in teaching. Also, this study seeks to test the adequacy of an extended TAM, the ICT Acceptance Model (ICTAM), by adding the construct of self-efficacy to use of ICT in teaching, perceived external barriers, and subjective norms. Moreover, it seeks to investigate the factors that affect the integration of ICT in teaching, and the extent to which ICT is used in the classroom in Kuwait. This research thus extends the scope of research using TAM and related models.

1.5 Purpose of study

The main research purpose was to investigate the factors that influence the integration of ICT in the classroom by developing a model that can predict primary science teachers' use of ICT in teaching. The research also sought to examine the extent to which ICT is used in the classroom. More specifically, the purposes of the study are:

1. To determine what factors affect ICT integration in the classroom and place them in a holistic model.

   The focus of this purpose is to identify factors from the literature that influence the use of ICT in teaching. Then, the identified factors are placed in a model to predict the acceptance of ICT integration. The relationships between the factors in the proposed model are established on the theoretical justification from the literature.

   2. To examine the validity and reliability of the proposed ICTAM model and confirm the ability of this model in predicting the behaviour.

   The focus of this purpose is to assess the capability of the proposed ICTAM to measure the acceptance of ICT from the viewpoint of female primary science teachers. The survey data is collected from these teachers to test the proposed model. Evaluating the validity and reliability includes testing the whole model, the constructs of the model, and the items used to measure each construct.

2. To study the causal relationship between those constructs in the context of the proposed ICTAM.

   This study investigates the direct relationship between the constructs and mediation. This helps in identifying the significance of these relationships. Moreover, perceived usefulness and perceived ease of use are selected to be mediation constructs in this study. Thus, the role of these two constructs is examined in this study.

3. To gain more information about the factors that affect teachers' use of ICT.

   This study used semi-structured interviews to gain more information about the factors that affect teachers' use of ICT, and the extent of ICT use in the classroom.

1.6 Theoretical Framework, Aims and Research Questions

The purpose of this study was to develop a model that could predict primary female science teachers' use of ICT. To serve this purpose, a widely used model, Technology Acceptance Model (TAM) was adapted (Davis, 1989).

The TAM is considered an appropriate conceptual framework for this study due to its simplicity and ease of understanding to examine behaviour. Also, TAM has been widely applied by researches to examine the acceptance of information technology. The TAM proposes that perceived ease of use and perceived usefulness are predictors of attitude toward use, and attitude toward use is predictor of behavioural intention, which has been linked to actual behaviour (Davis, 1989). According to TAM, the perceived usefulness and perceived ease of use are the key determinants of the behaviour.

The current study assumes that the inclusion of the new variables will enhance the ability of TAM to predict the technology acceptance of science teachers. The variables, subjective norms, perceived external barriers, and self-efficacy to use ICT in teaching, were added to the model to develop a theoretical model that explains science teachers' use of ICT in teaching.

The general competence of the TAM in modelling user acceptance of information technology has been demonstrated by studies that adopted TAM (Gao, 2008; Hasan & Ahmad, 2007; Liu, 2010). However, many researchers determined the importance of including new constructs to find a better model to understand teachers' use of technology (Nair & Da, 2012Teo, 2010; Teo, 2010a; Teo, 2010b).

By including the variables, subjective norms, perceived external barriers, and self-efficacy, the current study proposed Information and Communication Technology Acceptance Model (ICTAM), an adapted model of TAM (see Figure 1.1). Therefore, the aim of this study was to propose a model that can predict female science teachers' use of ICT by identifying the factors that affect teachers' actual use of ICT in teaching and the causal relationship between those factors. Consequently, this research attempts to investigate the factors that affect teachers' use of ICT.

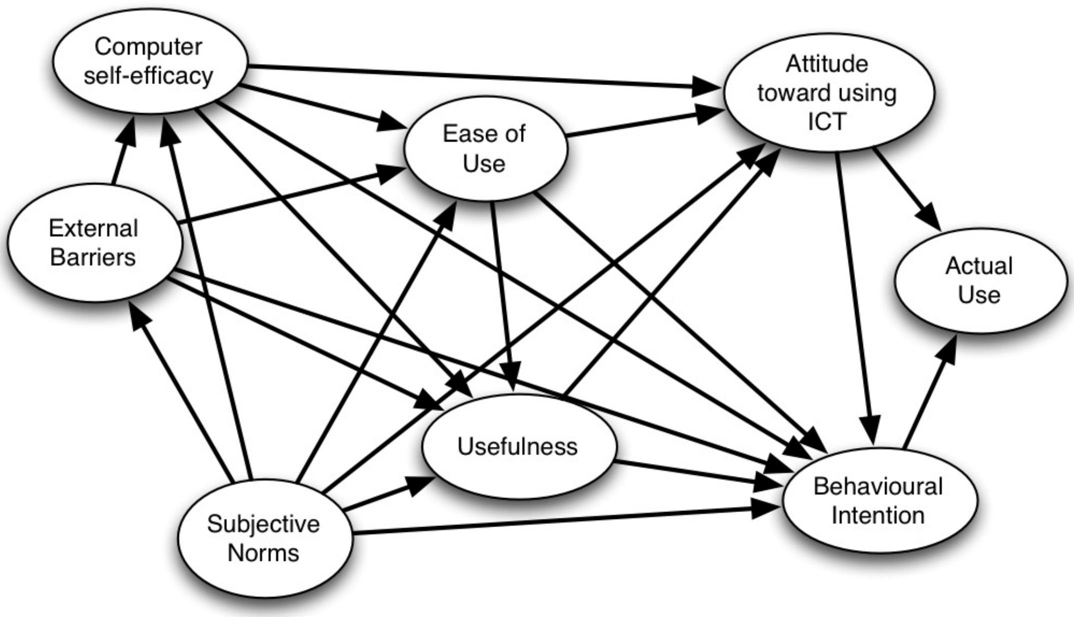


Figure 1.1: Proposed ICT Acceptance Model (ICTAM, modified from Davis et al., 1989, p. 985)

The research questions pertain to Kuwaiti female primary science teachers and their use of ICT in teaching. This study addressed three research questions:

1. How does the proposed ICTAM predict primary female science teachers' use of ICT in teaching?
2. What are the factors that prevent or encourage science teachers to use ICT in teaching?
3. To what extent do primary female science teachers' use ICT in teaching?

The first research question was developed to examine the ability of the proposed model (ICTAM) in predicting the acceptance of ICT by primary female science teachers. The survey method was used to help in answering this question. The second question was designed to obtain more in-depth information about teachers' perceptions regarding the factors that impact on their use of ICT in teaching and to serve for triangulation purposes. Semi-structured interviews were used to help in answering this question. The third question sought to provide evidence about the integration of ICT in the classroom. Semi-structured interviews were also used to help in answering this question.

1.7 Research Methodology

Details of the research methodology used in the current study are provided in Chapter 4. This section briefly describes the research methodology that was employed in this study.

This research study used a mixed method approach to collect the data. The data were collected by combining two methods, quantitative and qualitative. Creswell (2009) indicated that a mixed method approach provides a better understanding of the research problem than either type by itself. Questionnaire surveys and semi-structured interviews were used in a triangulated approach for collecting data on the same research problem (Johnson & Christensen, 2008). The advantages of triangulation are to improve the research findings and to gain a more complete understanding of the research problem (Hess-Biber, 2010).

Firstly, the survey data were conducted. A survey research method can be used to establish the basis for wider generalization (Creswell, 2009). The survey was used to assess the proposed model's ability to predict female primary science teachers' use of ICT in teaching, and this addressed the first research question. The relationships among the eight constructs (perceived ease of use, perceived usefulness, attitudes toward using ICT, behavioural intention, self-efficacy to use ICT, perceived external barriers, subjective norms, and actual use of ICT) were examined. Data were gathered from 500 female primary science teachers. Structural Equation Modelling (SEM) was used in the current study to assess the proposed ICTAM model and test the study model using AMOS 21. SEM is a common statistical approach that is used to test the relations among observed and latent variables (Hoyle, 1995). The structural equation model consists of two main sub-models: the measurement model and the structural model (Byrne, 2010). The measurement model specifies the observed variables (indicators) for each latent variable by using the confirmatory factor analysis (CFA) (Hair, Anderson, Tatham, & Black, 1998). The structural model assesses the reliability of latent variables and links the hypothesized variables to each other through systems of simultaneous equations (Schumacker & Lomax, 1996).

Secondly, the qualitative methods have the potential to provide more in-depth information about the research problem. The semi-structured interviews assisted in understanding research questions two and three: 2) what are the factors that affect female primary science teachers' use of ICT? and, 3) to what extent do female primary science teachers' use ICT in the classroom? Interviews were conducted with 21 female primary science teachers. Three types of teachers were selected on the basis of their frequency of use of ICT in teaching, to provide information-rich cases (Wiersma, 2000). The advantages of the semi-structured interview are that questions and content are organized in advanced for the triangulation of evidence (Denzin, 1978), there is flexibility to add further questions during the interview (Chambliss & Schutt, 2012), and the data provide a greater depth about the research problem (Gay & Airasian, 2009). The interview data were analysed using NVivo 10. The use of the interviews helped in triangulating the results obtained from the survey.

1.8 Terminology

In this study, integration of Information and Communication Technology (ICT) refers to the practical and theoretical aspects of using technology to contribute to science teaching and learning including: "tools for data capture, processing and interpretation-data-logging systems, databases and spreadsheets, graphing tools, modelling environments; multimedia software for simulation of processes; information systems; publishing and presentation tools; digital recording equipment; computer projection technology; and computer-controlled microscope" (Osborne & Hennessy, 2007, p.4).

1.9 Thesis structure

This thesis is divided into seven chapters, which are organized as follows:

Chapter 1: Introduction

This chapter includes an overview of the thesis and explores the context in which ICT adoption exists. It introduces a proposed model for investigating the factors that affect female primary science teachers' use of ICT. It then outlines the purpose of the study and its significance.

Chapter 2: Literature review

This chapter reviews the literature regarding relevant prior research. The areas discussed in the literature review include the definition of ICT integration, ICT adoption in education, impact of ICT on teaching, use of ICT in education, use of ICT in science classroom, and factors affecting teachers' use of ICT.

Chapter 3: Conceptual framework

This chapter provides a discussion of the conceptual framework on TAM and other theoretical models in the information technology and education areas.

Chapter 4: Methodology

This chapter describes the methods used in this study. It includes an overview of the research design, data collection instruments, operationalization of the research variables, statistical analysis, and interview analysis.

Chapter 5: Survey data analysis

This chapter addresses the first research question of the research. It reports on the results of the analyses and assessment of the measurement model.

Chapter 6: Interview data analysis

This chapter addresses the second and third research questions. It presents the interpretation of the findings derived from interviews.

Chapter 7: Discussion, conclusion and recommendations

This chapter presents a discussion of the survey and the interview findings. It provides a guideline for successful ICT integration. It finally concludes with the implications, limitations and strengths of this study, avenues for future research, and a summary of findings.

Chapter 2: Literature Review

This chapter reviews relevant literature on the use of Information and Communication Technology (ICT) in the classroom in order to describe the research context of the current study. The chapter consists of six sections. The first section reviews the literature that describes the adoption of ICT in schools. The second section addresses the studies that discuss the integration of ICT in teaching. The third section reviews the literature that describes the current uses of ICT in the classroom internationally. The use of ICT in the science classroom is addressed in section four. Section five reviews the literature that provides explanations about the factors affecting the use of ICT. Finally, section six provides a summary of the chapter.

2.1 Background to the literature

Technology has transformative potential to impact on the teaching and learning in Kuwait primary schools. However, there is debate about the role of technology and its impact on student achievement (Tamim, 2011). This literature review explores the nature of ICT for teaching particularly in the science classroom. There is substantial research internationally about the implementation of ICT. However, this problem is under-researched in Kuwait. The purpose of this study is to find if what is found internationally is applicable to Kuwait. Moreover, it is important that the effect of ICT and computers to improve students' learning is established so that the Ministry of Education can implement positive changes to science education.

2.2 ICT adoption in school

The research on adoption of ICT in schools shows that, despite the large investment in information and communication technologies, the pace of ICT adoption in schools is very slow (Moonen, 2008; Nchunge, Sakwa, & Mwangi, 2012; Reynolds, Treharne, & Tripp, 2003; Robertson, 2002; Rodriguez, Nussbaum, & Dombrovskaia, 2012; Tondeur, van Braak, & Valcke, 2007; Vanderlinde, Aesaert, & Van Braak, 2014) due to inadequate ICT literacy, lack of psychological and technical readiness and ineffective policy guidelines. Research suggests that to address this issue, psychological and technical skills of teachers need to be enhanced through increased investment in ICT facilities, resources and training so as to increase the slow rate of ICT adoption in schools (Alsulaimani, 2012; Nchunge et al., 2012). Research also suggests that the effectiveness and success of ICT systems depend not only on the technology itself, but also on the ways in which the users are introduced to the concept of ICT (Nchunge et al., 2012). Because of the above issues schools and institutions in most developing countries are increasingly facing the difficulty of managing and using ICT in classrooms (Gurcay, Wong, & Chai, 2013; Westrup et al., 2003).

Research also indicates that the important elements for successful adoption of ICT include an ICT teacher, an interested principal, and overall support in the school (Ilomäki et al., 2004). Even though there are many stakeholders with an interest in the adoption of ICT, the responsibility for implementing ICT in the classroom falls on the teacher. As a result, how competent and confident the teacher is in the use of ICT could contribute to their adoption of ICT (Cooke & Dawson, 2012; Rogers & Twidle, 2013; Wastaiu et al., 2013).

Moreover, studies, in various countries, indicate that there is a relationship between the integration of ICT and a strong, professional, teachers' community. Teachers' with an interest in learning about technology contributes to the development of the professional community, which in turn contributes to more integrated and focused uses of technology and adoption of a support system for technology use (Dexter et al., 2002). In schools that organise computers for teachers' use and provide appropriate support and training, teachers feel a personal commitment to adopt ICT with enthusiastic support of the principals (Granger et al., 2002; Holland, 2001).

The research shows that in addition to teachers' professional development in ICT skills, as a consequence of the integration of ICT in schools, the teachers become more interested in adopting ICT, and they demand better technical applications (Nchunge et al., 2012). The technological infrastructure helps them to implement new pedagogical practices and they also create personal ways of using ICT in their teaching (Ilomäki et al., 2004).

Keeping in view the above discourse, we can safely assume that the use of ICT has brought several changes in teaching practice and student learning since its adoption and use in schools. Because of this adoption and interactive use of technology the student-centred approach in learning has become the leading approach (Ilomäki et al., 2004). Research indicates that adoption of ICT as a learning tool helps students gain the ability to collect, process, and construct information, while teachers adopt technology-enabled learning as part of their teaching (Ertmer & Ottenbreit-Leftwich, 2013).

With all the advantages of technology in the classrooms, ICT-related reforms require that in addition to adopting technology, ICT is integrated in the teaching practices. This will require that teachers learn both new technology and how to make profound changes in the traditional teaching practice (Nchunge et al., 2012).

2.3 ICT integration in teaching

There is a growing emphasis to integrate ICT in the educational policies internationally (Ward & Parr, 2010). The integration of ICT has been defined in different contexts by different researchers. For instance, Jonassen et al. (2003) defined the integration of ICT as the sustainable and persistent change in the social system of schools caused by the integration of ICT to help students construct knowledge through research and analysis of information to solve problems. In another study, ICT integration is defined as the use of instructional ICT to develop curriculum delivery (Griffin, 2003). According to Vanderlinde, Aesaert, & Van Braak (2014, p. 1) "ICT integration means that ICT is used in education to foster teaching and learning processes".

ICT use is always mentioned with ICT integration in the literature (Afshari, Bakar, SuLuan, Samah, & Say, 2009; Meneses, Fàbregues, Rodríguez-Gómes, & Ion, 2012; Tondeur, van Braak, & Valcke, 2007). Therefore, ICT integration for teaching and learning is increasingly being pursued in primary schools across countries (Vanderlinde, van Braak, & Hermans, 2009). Teachers and schools try to integrate the use of ICT in their practices to improve students' learning skills (Anderson, 2008).

The use of ICT is measured differently in different contexts. Examples include the frequency of ICT use during classes and the frequency of use of specified types of

ICT applications (e.g. word processing, e-mail, etc.) (Vanderlinde et al., 2014). On the other hand, many researchers operationalise ICT use in terms of use as either the subject of study or as an instructional tool to teach other content (Vanderlinde et al., 2014). More recently, researchers emphasise that ICT can be integrated in many different ways in classrooms for different types of uses. For instance, Tondeur et al. (2007) make a distinction between three types of computer use: use of ICT as an information tool, use of ICT as a learning tool, and learning basic computer skills. Meneses et al. (2012) make a distinction between supportive use and management use. The supportive use is linked to classroom preparation activities like finding supplementary information for lessons. Management use is related to teachers' general duties in the functioning of schools as organisations (e.g. performing administrative tasks, communicating with colleagues, interaction with parents and students).

In a study on institutionalised ICT use in primary education, interaction of different contributing factors such as ICT professional development, ICT competencies, and developmental educational beliefs were identified as variables associated with ICT use (Vanderlinde et al., 2014). The study implied that the teachers' ICT competencies were interconnected with ICT professional development activities and encouraged teachers to use ICT in the classroom (Vanderlinde et al., 2014).

The current study continued the exploration for the integration of ICT in the classroom (Meneses et al., 2012; Ward and Parr, 2010), with additional elements to focus also on the frequency of use of ICT in teaching, and the extent to which ICT is used in the classroom. Therefore, the following section reviews the literature regarding the actual uses of ICT in the classroom.

2.4 Teachers' use of Information and Communication Technology

Research shows that ICT supports the use of a constructivist approach to teaching and learning (Niederhauser & Stoddart, 2001; Vanderlinde, Aesaert, & Van Braak, 2014). ICT and technology are said to facilitate technology-enhanced and student-centred learning environments (Hannafin & Land, 1997). Teachers use ICT as a tool to help students master the information and communication systems skills (Anderson, 2008), foster self-regulated learning strategies (Karabenick, 2011), and involve students in learning activities (Harris, in Anderson, 2002).

Many researchers have conducted studies to investigate to what extent teachers use ICT, and the way technology is being used in the classroom. This section reviews some of the most significant literature regarding the frequency of teacher use of ICT, and the ways technology is used in the classroom. In this review supportive use refers to using technology for lesson preparation, facilitating students' learning, communication, administrative tasks, or internet access. Some specific examples of supportive use of ICT could include word processing of lesson plans, Excel spreadsheets for tabulating science results from experiments, email communication, students' grades and reporting, and the use of websites to research science content knowledge. Instructive use reflects the desired integration of technology by teachers, and refers to using technology in the classroom for problem-solving, investigations, or as a productive tool (Salleh, 2005). The instructive use of technology could include specific approaches that involve science simulations and virtual experiments to enhance critical and creative thinking using PowerPoint, digital cameras, and data logging.

In the USA, the literature from the past two decades showed that over the years the use of technology progressed from non-use to low use to using it as a supportive tool or as an instructive tool. For instance, in a study conducted by Mathews (1998) that involved 3500 teachers in 55 rural school districts in south-eastern Idaho, the majority of teachers never used the internet in the classroom, while more than half of the teachers categorized themselves as novices in the use of computers.

Evidence from the literature showing the progress of using technology is provided by Barron, Kember, Harmes, and Kalaydjian (2003). Their study involved 2156 K-12 school teachers in Florida, in one of the largest school districts in the USA, to explore the use of technology as a classroom research, communication, productivity, and problem solving tool. They found that around 50 per cent of the teachers who participated in the survey used technology for communicative purposes, while a minority of teachers used technology as a research, problem-solving, and productivity tool. Across subject areas, they reported that science and mathematics teachers used technology as a problem-solving or research tool more than teachers of other subjects such as English and social studies.

Moreover, there is evidence in the literature for instructional use of technology, which is illustrated by a national survey conducted in the USA in 2006. Research on the Teachers Talk Tech in-depth survey that was conducted by CDW-G, a leading provider of integrated information technology solutions in the U.S. and Canada, with more than 1000 K-12 teachers across the USA reported that 88% of the teachers used technology for administrative tasks; 86% used technology for communication tasks, 81% of the teachers used technology for lesson preparation, while 79% used technology as an instructional tool (CDW-G, 2006). These findings demonstrated that the use of ICT has progressed from using ICT as a supportive tool to using it for both supportive and instructive uses compared to previous studies (Barron et al., 2003; Mathews, 1998).

However, a recent study showed that the use of technology is mostly for supportive rather than instructive uses (Project Tomorrow, 2010). The "Speak Up 2010" survey was conducted by Project Tomorrow involving 294399 K-12 students, 42267 parents, 35525 teachers, 2125 librarians, 3578 school administrators and 1391 technology leaders in USA schools. The findings were that 96% of the teachers used communication tools to connect with colleagues and parents. However, 36% of the teachers used these tools to connect with students. Also, 58% of the teachers used technology to facilitate students' learning by asking students to complete homework assignments and practice using computers; this percentage was 16% higher in 2010 than in 2008. However, there was no or little growth from 2008 to 2010 in using technology to set students objectives; provide feedback to students on performance; and to track the relationship between students' efforts and achievement (Project Tomorrow, 2010). These results indicated that despite teachers' use of technology occurring more often, it may still be irregular. Also the results indicated that the supportive use of technology was more prevalent than instructive use (Project Tomorrow, 2010).

The literature indicates that the way of using technology is similar across the world. For example, Ward and Parr (2010) conducted a survey study involving 199 teachers from four New Zealand secondary schools to investigate their use of ICT. Their study investigated the type of use according to five factors which are generic pedagogical use (using computers with students as a productivity tool that is not limited to particular subjects); specific pedagogical use (using computers with students to learn specific facts and skills that are limited to a particular subject); preparation and presentation of lesson material; core professional use (administrative and reporting tasks); and personal use (non-work related tasks). The major findings of the survey were that teachers mostly used computers for core professional use and personal use rather than for generic pedagogical use, specific use, and preparation and presentation of lesson materials (Ward & Parr, 2010). These results indicated that teachers used the computer as a supportive tool rather than using it as an instructional tool.

In Hong Kong, mixed methods of surveys, interviews and classroom observations were used to investigate ICT adoption by 252 Home Economics teachers (Ho & Albion, 2010). With respect to the level of use, Ho and Albion (2010) reported that 61% of the teachers used computers less than 5 hours per week for teaching despite the availability of computers in the classroom; whereas 8.8% used computers for more than 10 hours per week for teaching. For the frequency of use they reported that 40% of the teachers used computers at least weekly, 53% used computers twice per month, while 8.7% used computers once or twice a year or not at all (Ho & Albion, 2010). They reported that, despite the availability of computers and the internet in the classroom, teachers prefer to conduct traditional didactic lessons.

In Turkey, Gulbahar and Guven (2008) conducted a survey study of 326 primary school social studies teachers. They found that despite 98.2% of social studies teachers having access to computers at work, over 50% of them used computers for less than one hour a day, and 1.5% used a computer for more than five hours a day (Gulbahar & Guven, 2008). Moreover, they found that less than 20% of the teachers used educational software. These results demonstrated the low use of ICT for instructive purposes.

Another survey study in Turkey collected data from a representative sample of 1540 teachers in public primary schools (Tezci, 2009). It found low use of ICT for learning-teaching processes. The common activities involving the use of ICT were using the internet, email, word processing and educational software. Other forms of ICT were rarely used. Tezci (2009) commented that the use of ICT in the classroom was limited. This limited use suggested that the teachers used the technology just for supportive purposes rather than instructive purposes.

Also, research on teacher educators has shown that the computer is used only for supportive purposes. In Vietnam, a survey study of 783 teacher educators reported that 73.7% of teacher educators sometimes or regularly used word processing software for production of documents, 55% used presentation software for lecturing, and 73.6% used internet to access information. A minority of teacher educators used subject specific applications for integration into lesson practice; and electronic communication with students (Peeraer & Van Petegem, 2011).

Evidence from the literature showed similarity between countries regarding the frequency of use of ICT and its relationship with using a learner-centred approach in the classroom. For example, based on the Second Information Technology in Education Studies (SITES) database that was collected in 2006, Pelgrum and Voogt (2009) compared countries with a relatively high percentage of mathematics teachers frequently using ICT (HIMA) with countries with a relatively low percentage of mathematics teachers frequently using ICT (LOMA). The Pelgrum and Voogt (2009) study investigated three constructs, 1) school factors (such as school leaders' pedagogical practices, technical support, and teacher development programs); 2) teacher factors (such as pedagogical and technology competences, vision, and perceived barriers); and 3) characteristics of the change factors (learning resources, perceived impact of ICT, and teacher practice orientation) that were measured via questionnaires for school leaders, ICT coordinators and teachers. With regard to teacher level, Pelgrum and Voogt (2009) reported that mathematics teachers in HIMA countries utilized a learner-centred approach in the class and focused on lifelong learning, more than mathematics teachers in LOMA countries. Moreover, with regard to school level, they found that school leaders in HIMA countries encouraged teachers to use ICT and apply ways of teaching and learning more than school leaders in LOMA countries. Pelgrum and Voogt (2009) further recommended investigating the factors that affect other teachers' use of ICT.

A recent study that investigated the teachers' actual use of ICT in the classroom was conducted by Agyei and Voogt (2014). The study involved 100 beginning teachers who had attended a professional development program that was named 'learning technology by collaborative design' in their final year of their pre-service preparation program. The learning collaborative design course is intended to develop teachers' competencies in ICT integration by using ICT-based curriculum materials. The results of the study found that the beginning teachers held positive views towards using ICT-enhanced activity-based learning activities in the classroom. Also, the results demonstrated that the teachers used ICT-enhanced activity-based learning activities in their teaching such as using teamwork among their students, using lesson notes in guiding lessons, using activity-based pedagogical approaches, interactive demonstrations using spreadsheets, and using spreadsheet techniques. These uses of ICT in the classroom suggested that teachers used ICT for instructive purposes.

This literature review so far has described the trend of technology use in terms of frequency of the use and ways that ICT has been used in the classroom. Although most of studies above demonstrated that the teachers used technology for supportive purposes rather than instructive purposes (Gulbahar & Guven, 2008; Tezci, 2009), some of these studies found that the teachers used ICT for instructional purposes (Agyei & Voogt, 2014; Pelgrum & Voogt, 2009). In addition, despite the important findings that were mentioned in these studies, most of these studies used a survey method to find out the extent to which ICT was used in the classroom. Therefore, there is a need for mixed method studies that provide more in-depth information about the actual use of ICT in teaching and how ICT is used by teachers. Moreover, the finding from the review showed that science teachers used technology as a problem-solving or research tool more than teachers of other subjects such as English and social studies (Barron, 2003). This provides the motivation to study those teachers in greater depth to find out why those teachers use ICT more than the others. The following paragraphs discuss science teachers' use of ICT in classroom.

2.5 Use of ICT in science classroom

Research indicates that interest in science can be stimulated by introducing innovative and dynamic teaching/learning environments to change the classroom experience from being limited to just facts to be memorised into a vibrant subject (Daniel, 2013). Specific example of the use of ICT with science could include: digital recording equipment, computer controlled telescopes or microscopes, multimedia software for simulation and virtual experiments, spreadsheets and graphing tools, modelling environments, data-logging systems, and publishing and presentation tools.

Osborne and Hennessy (2003, p. 20) indicated that ICT offers a lot of tools that can be used in science classrooms to enhance the teaching and learning. Five specific and nuanced discipline-specific uses of ICT include:

i. Tools for data capture, processing and interpretation-data-logging systems, databases and spreadsheets, graphing tools, modelling environments (e.g Insight, and Excel).
ii. Multimedia software for simulation of processes and carrying out virtual experiments (e.g CD-Roms, and DVDs).
iii. Information systems (e.g. CD-ROMs, and Internet).
iv. Publishing and presentation tools; digital recording equipment (e.g. Word; and PowerPoint).
v. Computer projection technology (e.g. data projector & screen, external monitor or TV).
vi. Computer-controlled microscope.

Research indicates that school science lacks authenticity and has little to do with publicly debated issues (Roth, Eijck, Reis, & Hsu, 2008). This lack of authenticity has been associated with students' lack of interest and motivation in science (Bolstad & Hipkins, 2008). Therefore, ICT-rich environments enable learning of science in schools when teachers use simulations, microworlds, modelling and data-logging which enhance learning (Cox & Abbott, 2004; Webb, 2008). Fensham (2006) discusses that science education should provide opportunities for students to engage with real-world science and technology to solve the problem of declining student interest in science. The use of technology in science classrooms has been demonstrated to expand work productivity; provide access to experiences not otherwise feasible; provide immediate visual feedback; enhance collaborative learning; and improve motivation (Osborne & Hennessy, 2003). For instance, research demonstrated that student participation in inquiry has been shown to enhance student interest in science. Inquiry is one of the common approaches used in science classrooms.

Inquiry comprises the development of the students' ability to be able to conduct scientific investigations, to gain understandings about the nature of scientific inquiry, and to master scientific concepts by using teaching and learning strategies through investigations (NRC, 2000).Research has indicated the importance of ICT to support science inquiry. For example, a study was conducted in New Zealand to investigate how e-networked approaches could support scientific inquiry. Williams et al. (2013) used classroom observation before and during the lesson, and video-recordings and transcripts from the classroom. The e-networked tools that were used in the study to help students investigate, share, and co-construct were: online search for information, YouTube, webquests, mobile devices to access ideas and resources, and presentation tools to communicate. The results demonstrated that e-networked tools supported science inquiry aspects. Moreover, the results indicated that these tools helped students to exercise agency, share their own and others' input, and access sources of information. However, teachers' integration of science inquiry with e-networked tools was enabled and constrained by multiple factors. These factors were: reliable access to technology, flexible curriculum and assessment structures, teachers developing understanding of the affordances of the different technologies, and teacher planning to incorporate technology meaningfully in their teaching.

The integration of technology in science teaching/learning skills has meant that researchers look for affordances and constraints to reveal new opportunities for teaching/learning (Rogers & Twidle, 2013). Affordance is a term used to describe opportunities provided for users in ICT-based learning environments. Gibson (1979) described affordances as what the environment offers the users. Gibson's definition of affordances, "complementarity of the animal and the environment" (Gibson, 1979, p. 127) was derived from his ecological theory of perception in which affordances depend on the potential for interaction between organisms and their environment. "Just as in an ecological system in which affordances for a particular organism depend on the interaction between the organism and the environment and interactions with other organisms, in an ICT-supported learning environment affordances are interactions between the hardware, software, other resources, teachers and students" (Webb, 2005, p. 707). Many research studies have identified specific affordances and their potential for supporting learning (Webb, 2005). These affordances help build conceptual change, develop thinking skills in science, and promote research and development of formative assessment and curriculum innovations (Cox & Webb, 2004). For example, studies of computer simulations of experiments (Monaghan & Clement, 1999; Tao & Gunstone, 1999) let us identify affordances, learning outcomes, and associated pedagogical practices that lead to conceptual change. Computer simulations provide affordances for learning about phenomena that cannot be easily observed and explored in the real world (Webb, 2008).

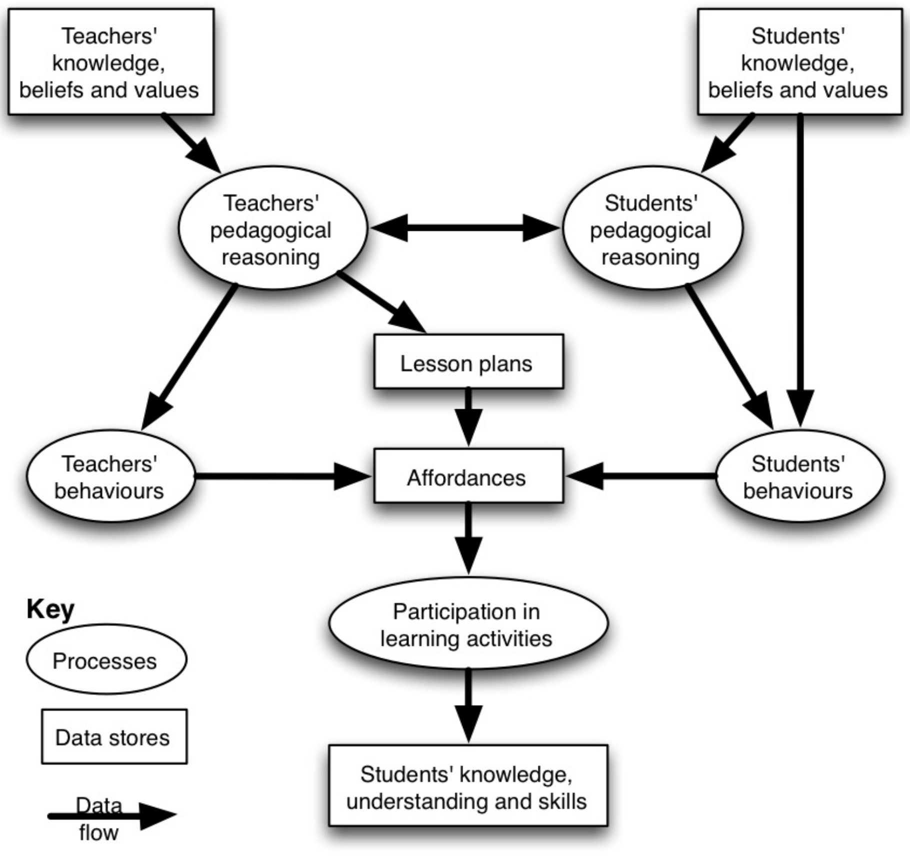


Figure 2.1: Framework for pedagogical practices relating to ICT use (Webb, 2008, p. 141)

Figure 2.1 is a framework for pedagogical practices relating to ICT use. It depicts how teachers' and students' beliefs and values about the importance of ICT for learning lead to the teacher developing lesson plans that include affordances for learning through technology. The teachers' behaviour and students' behaviour enable students to benefit from these affordances. The students' behaviour enables the teacher to determine the alternative conceptions among students and based on these conceptions identify and provide appropriate affordances so that students are motivated to use technology to develop the knowledge skills and understanding of science.

Many researchers state that teachers are still clinging to traditional methods instead of using ICT in their teaching (Barak, Ashkar, & Dori, 2011; Jimoyiannis, 2010). Research in Kuwait also indicated that science teachers still use traditional practices in the classroom (Alayyar, Fisser & Voogt, 2012). A study among 22 countries based on the Second Information Technology in Education Studies (SITES) to understand the way teachers and students use ICT in teaching and learning revealed that science teachers use of ICT was low and highly variable across countries due to lack of equipment (Law et al., 2008). Barak (2014) indicated that despite the existence of obstacles that affect the integration of ICT, such as time needed to efficiently integrate ICT in the classroom and lack of equipment, teachers' attitudes and perceptions shape the integration of ICT in the classroom. As teachers' attitudes and perceptions can support or work against the use of ICT in teaching, "in order to obtain a successful curriculum reform, it is required to understand teachers' beliefs and their influence on the implementation of innovations" (Barak, 2014, p. 3).

While it is important to identify how technology is used in science classrooms and how often, it is more important to find out the reasons behind teachers' low use, and the best ways to encourage teachers to use ICT in the classroom, so that reinforcement initiatives could be put in place. The following section describes the literature that explains the reasons behind limited or enhanced use of ICT in the classroom.

2.6 Reasons behind limited or enhanced use of ICT in the classroom

A vast amount of money has been invested in installing computers, technology infrastructure and internet connectivity into schools. Also, huge investments of time and effort have been used in the endeavour to implement technology in the classroom. It has been urged that providing technology in schools will change teachers' practice (Peeraer & Van Petegem, 2011). Also, Chen (2010) emphasized the importance of using technology to support student-centred learning. However, teachers have made limited effective use of technology in the classroom (Aldunate & Nussbaum, 2013). Of the published research on teachers' use of ICT, some studies attempted to identify the reasons behind limited use of ICT (Agyei & Voogt, 2014; Hashemi, 2013). An understanding of the aspects that impact teachers' use of ICT is crucial in order to maximise benefits from the investment in money and time for ICT implementation in classrooms.

Some argue that the reason behind the limited use of technology in the classroom is low teaching and learning impact. Others argue that finding the time to prepare materials for lessons is the reason behind the limited use of technology in the classroom. Still others propose that teachers' attitudes affect the use of technology in the classroom. The literature has presented different explanations of the reasons behind the limited use of technology in the classroom. However, there are also explanations of enablers of technology use. Some demonstrate that the availability of technology is the reason behind the enhanced use of ICT in the classroom. Others argue that teachers' confidence enhances teachers' integration of ICT in the classroom.

The following paragraphs review the literature regarding the aspects that influence teachers' use of ICT. In reviewing the literature, the current study categorizes the studies into four sections according to terms used in these studies. For example, the studies that used the term *factors* are discussed in one section, the studies that used the term *barriers* are discussed in another section, the studies that used the term *enablers* are addressed in a different section, and finally the studies that used the terms *enablers and barriers* are discussed in another section.

2.6.1 Factors affecting teachers' use of ICT

Many research studies examined the factors that affect teachers' use of ICT, so it is useful to view these studies to identify the factors that have impact on the integration of ICT in teaching, which teachers have faced for approximately two decades. In Australia, Norton, McRobbie, and Cooper (2000) in their case studies of five mathematics teachers, investigated the factors that affect mathematics teachers' use of ICT. The authors found that mathematics teachers rarely used computers in their teaching despite the availability of computers for mathematics staff. The results indicated that teachers' resistance was related to their beliefs that teaching practices which assist with the completion of the syllabus and help students with passing examinations, were more important to meet their educational goals than consuming time using computers.

Mumtaz (2000) reviewed the literature from 1980 to 2000 that focused on factors that affect teachers' use of ICT and found that teachers' beliefs toward using ICT, lack of resources (time, technical support, computers and software), and the role of the school in supporting teachers' use of ICT are the major factors that affect teachers' use of ICT.

Similarly, Ertmer (2005) reviewed the literature from 1982 to 2003 to examine the effect of teachers' pedagogical beliefs on their technology practices. She found from the review that teachers' beliefs about technology affect their behaviour in the classroom. However, she suggested three strategies to change teachers' beliefs about using technology in teaching (1) personal experiences (such as basic uses of technology), (2) vicarious experiences (such as a supervising teacher's uses of technology), and (3) social-cultural influences (such as providing professional learning community) (Ertmer, 2005).

The international study conducted by Pelgrum and Voogt (2009) investigated the factors affecting the implementation of ICT (discussed earlier in this chapter). In this study the researchers developed constructs for the school level (such as leadership activities, technical support, staff development); and teacher level (such as technical competence, vision, beliefs, and perceived obstacles); as well as constructs characterizing the change itself (such as curriculum goal orientation, teacher practice orientation, presence of community of practice). Pelgrum and Voogt (2009) compared the data from countries with a relatively high percentage of frequently ICT-using mathematics teachers with countries with a relative low percentage of frequently ICT-using mathematics teachers. For example, there was positive correlation between teachers' perceptions about using student-centred approaches in their classes and their frequent use of ICT. For instance mathematics teachers in the countries that have a relatively high percentage of frequently ICT-using teachers used a student-centred approach and focused on lifelong learning competencies in their classes more than mathematics teachers in the countries that have a relatively low percentage of frequently ICT-using teachers. Also, there was positive correlation between teachers' perceptions about technical support and their frequent use of ICT. For instance, in the countries with a high percentage of frequently ICT-using teachers they found that school leaders supported teachers' development of ICT skills and ICT-supported pedagogical skills more strongly compared to those in the countries with a low percentage of frequently ICT-using teachers.

A recent review of the literature conducted by Ertmer and Ottebreit-Leftwich (2010) focused on four variables related to teacher change: knowledge, self-efficacy, pedagogical beliefs, and subject and school culture. They indicated that these four variables are important and should be considered to make successful change in teachers' use of ICT in the classroom. They also suggested recommendations for facilitating teacher change in pre-service teacher education and in-service professional development.

The pre-service teacher education recommendations were 1) knowledge and skills (such as hands-on experience with technology tools; observations of best practice technology use; readings and discussions of research papers of best technology practices that promote student achievement; and preparation to use technology in the classroom as an instructional tool), 2) self-efficacy (such as opportunities to use technology in college and classroom; having experience to teach with technology; and access to models and examples), 3) school subject/culture (such as efficient use of technology in college; designing plans to reduce pressure at school that coincides with technology use; cooperation with schools and teachers to integrate technology; conducting seminars on teachers' roles as scholars, researchers and lifelong learners), 4) pedagogical beliefs (such as a discussion of current beliefs; and taking advantage of successful experiences of others who use new approaches to improve students' achievement).

The in-service professional development recommendations were 1) knowledge and skills (such as practice to use technology that aligns with pedagogical content knowledge; meetings with teachers to discuss the best technology uses to increase students' achievement; provide technology professional development sessions within the school community; provide discussions and support directly after professional development experiences; give chances for helpers to practise managing technology with teachers in the classroom), 2) self-efficacy (such as give the opportunity to share successful experiences using technology to enhance student learning outcomes; provide opportunities to watch other teachers using technology in their classroom; and promote a community that supports experimentation), 3) pedagogical beliefs (such as providing professional development initiatives commensurate with teachers' beliefs), 4) school/subject culture (such as professional development plans that include technology; shared vision; participation in partnerships to integrate technology in classroom; design professional development that encourage the teachers' roles as scholars, researchers and lifelong learners) (Ertmer & Ottenbreit-Leftwich, 2010).

A recent study was conducted to investigate the factors that affect teachers' use of ICT in the classroom after doing a professional development program (see section 2.3). The study was conducted by Agyei and Voogt (2014). The results demonstrated that teachers' pedagogical beliefs affected their use of ICT in the classroom. These beliefs were attributed to their active use of ICT in the classroom and were held for several months after finishing the development program. Moreover, perceived dissatisfaction with the *status quo* was another factor that affected teachers' use of ICT in the classroom. The teachers demonstrated the desire to change existing teaching approaches towards approaches that were integrated with ICT. In addition, perceived commitment was another factor that promoted transfer of learning into an ICT-enhanced activity-based learning environment. All the above studies focused on the factors that influence teachers' use of ICT in the classroom.

The literature also shows that the factors that affect the teachers are the same factors that affect the pre-service teachers regarding the integration of ICT. For example, in the USA, a study conducted by Brush, Glazewski, and Hew (2008) developed a reliable and valid survey instrument to measure pre-service teachers' technology skills, beliefs and barriers. They surveyed 176 pre-service teachers at a major South-western university in the USA. They found that the use of technology by pre-service teachers is affected by factors such as the beliefs and technology skills of teachers, and technology barriers (such as lack of access to available technology, lack of time, and lack of technology support). The major results were that, although the teachers had positive attitudes toward the importance of using technology in the classroom, they lacked technology skills. With regard to barriers, they found that the lack of technology knowledge and technology integration techniques were the major barriers to ICT integration.

In general, it appears that the factors that affect teachers' use of ICT are similar across the countries, and also the strategies to overcome these barriers. The following paragraphs review the literature about the studies that discussed the barriers and enablers separately, and then discuss the literature that included both barriers and enablers in their research studies.

2.6.2 Barriers to using ICT in the classroom

As a means to understand the reasons behind the limited use of ICT, it would be useful to identify the barriers that prevent teachers from using ICT in the classroom. A useful survey study was conducted by Jones (2004) on 170 educational practitioners in the UK regarding the barriers that may hinder them from using ICT. The barriers were categorized into teacher level barriers and school level barriers. The results were that the teacher level barriers were: lack of appropriate professional development programs, low levels of confidence, resistance to change, disbelief about the advantages of using ICT, and anxiety. In turn, the school level barriers were: technical problems with ICT equipment, impact of public examinations, and lack of time needed to prepare materials for lessons. Also, it has been seen that even in schools that have abundant technological tools, most teachers still might not be using them in their classroom due to the lack of access. Moreover, the lack of computers, and sometimes software, were a major hindrance in implementing ICT. The implementation process may not be a priority if essentials like computers are not in place. The study also found the barriers were interrelated, for example, the barriers of personal access to ICT, technical support, and training have directly affected teachers' confidence (Jones, 2004).

In Singapore, Lim and Khine (2006) conducted a case study to examine the strategies employed by four schools (two primary and two junior colleges) to manage barriers to ICT integration. They categorized the barriers as 1) first-order barriers and, 2) second-order barriers. This categorization was based on the work of Ertmer (1999) who defined first order barriers as the external obstacles that hinder teachers from using ICT such as lack of time, and lack of support. Second order barriers are the internal obstacles (beliefs) that rarely noticed by the teachers themselves or by others. According to Lim and Khine (2006) the results were that the first-order barriers were lack of time to use ICT in the classroom, lack of time to prepare materials for lessons, and lack of computer software. The second-order barriers were disbelief about the benefits of using ICT in the classroom, resistance to change, and reluctance to share failures. Moreover, they proposed strategies based on their results, "(a) appointment of technical support staff, (b) appointment and training of student ICT helpers, (c) sufficient time for teachers to prepare for ICT-mediated lessons, (d) collaboration among teachers in preparing ICT-mediated lessons, (e) support provided by school leaders in addressing teachers' ICT concerns, and (f) training" (p. 97).

Hew and Brush (2007) analysed empirical studies from 1995 to 2006 that focused on the barriers affecting the use of computers in K-12 schools, and distinguished six categories that are examined in the literature: 1) resources, 2) knowledge and skills, 3) institution, 4) attitudes and beliefs, 5) assessment, and 6) subject culture. From their analysis, they found that there were two kinds of barriers that affect the integration of technology, direct and indirect barriers. The direct barriers were teachers' beliefs and attitudes toward using technology, teachers' knowledge and skills, institution, and resources. The indirect barriers were subject culture and assessment. The analysis indicated that the barriers were interrelated; for example assessment affects subject cultures. Also, the adequacy of resources is affected by the institution. In the conclusion of their paper, Hew & Brush (2007) described various strategies to overcome these barriers. They proposed that these barriers can be overcome by providing a shared vision and developing an integration plan; by providing ample technological resources; by influencing the beliefs and attitudes of the teachers; and by giving professional development training sessions.

In the USA, Gulbahar and Guven (2008) in their study (discussed earlier in this chapter) investigated the barriers that affect social studies teachers' use of ICT. They found that the barriers were lack confidence in using ICT in the classroom, lack of technical knowledge to prepare materials based on technology, and lack of in-service ICT training. However, they found that lack of technical knowledge to prepare materials based on technology was the major barrier that affected teachers' use of ICT (Gulbahar & Guven, 2008). They indicated that there were interrelationships between some of the identified barriers to ICT use; for example, teachers' confidence was directly affected by another barrier, the amount of in-service ICT training.

In Australia, Hudson, Porter, and Nelson (2008) investigated the barriers to using ICT in the classroom which were experienced by secondary mathematics teachers. They surveyed 114 teachers from public schools in New South Wales. They found that lack of access to computer labs was the highest barrier that affected mathematics teachers' use of ICT. However, a second analysis using logistic regression analysis modelling of the results indicated that the barrier, 'lack of lesson plans', was higher for non-users of ICT compared to teachers who used ICT in their classes. At the end of their study they recommended that the schools should provide professional programs for teachers and train the non-users to use technology in their lesson plans.

In Oman, a survey study conducted by Al-Senaidi et al. (2009) in higher education involving 100 faculty members at the College of Applied Sciences identified five major factors that are considered as perceived barriers in adopting ICT. These barriers are lack of resources, time, support, confidence, and negative beliefs about the usefulness of ICT. The study suggested that teachers should be provided with more training, support and time to help them promote and learn newer educational technologies.

In the USA, a case study was conducted by Kopcha (2012) to investigate the barriers that have an influence on the teachers' use of technology in teaching. The study was based on the data collected from survey, interviews, and observations from 18 elementary teachers. The results demonstrated that teacher belief is one of the most important factors that affect the integration of ICT in teaching. Moreover, time was another barrier that interrupted instruction. In addition, access to technology was also a barrier that impacted the ICT usage in the classroom. Further, lack of professional development programs that are related to the classroom practices was another barrier that impacted on the integration of ICT.

In Saudi Arabia, Alsulaimani (2012) explored the barriers that prevent science teachers from using ICT in the classroom. The author used a survey method and the data were gathered from 309 science teachers in Jeddah. The study reported that there were ten barriers that impeded science teachers from using ICT in the classroom. The barriers were: 1) insufficient time in the weekly schedule to use ICT in the classroom, 2) inadequate ICT equipment, 3) large numbers of students in the classroom, 4) lack of sufficient room to use ICT in teaching, 5) lack of technical support, 6) lack of a technology integration plan to use ICT in the classroom, 7) slow internet speed, 8) lack of internet connection, 9) lack of appropriate ICT training, and 10) lack of Arabic software.

In general, even though the studies have used different categorizations such as first order barriers/second order barriers; school level barriers/teacher level barriers; and direct barriers/indirect barriers, the barriers to use ICT appear to be common across the countries, and there are interrelationships between barriers. Table 2.1 below shows the barriers linked to research studies.

Table 2.1: Barriers linked to research studies

Barriers	Research studies
Lack of appropriate professional programs	Jones (2004); Gulbahar & Guven (2008); Kopcha (2012); Alsulaimani (2012)
Lack of confidence	Jones (2004); Gulbahar & Guven (2008); Al-Senaidi et al. (2009)
Resistance to change	Jones (2004); Lim & Khine (2006)
Disbelief about the advantages of using ICT	Jones (2004); Lim & Khine (2006); Hew & Brush (2007); Al-Senaidi et al. (2009); Kopcha (2012)
Anxiety	Jones (2004)
Lack of technical support	Jones (2004); Hew & Brush (2007); Al-Senaidi et al. (2009); Alsulaimani (2012)
Lack of time needed to prepare materials for lessons	Jones (2004); Lim & Khine (2006); Alsulaimani (2012)

Lack of access to technology	Jones (2004); Hew & Brush (2007); Hudson, Porter, & Nelson (2008); Kopcha (2012)
Lack of technology	Jones (2004); Lim & Khine (2006); Hew & Brush (2007); Al-Senaidi et al. (2009); Alsulaimani (2012)
Impact of public examination	Jones (2004); Hew & Brush (2007)
Lack of time to use ICT in the classroom	Lim & Khine (2006); Hew & Brush (2007); Al-Senaidi et al. (2009); Kopcha (2012)
Reluctance to share failures	Lim & Khine (2006)
Leadership	Hew & Brush (2007)
Time-tabling	Hew & Brush (2007)
Structure	Hew & Brush (2007)
School plan	Hew & Brush (2007)
Lack of technology skills	Hew & Brush (2007); Gulbahar & Guven (2008)
Subject culture	Hew & Brush (2007)
Lack of lesson plan	Hudson et al. (2008); Alsulaimani (2012)
Internet problems	Alsulaimani (2012)
Lack of Arabic software	Alsulaimani (2012)

2.6.3 Enablers to use ICT in the classroom

After reviewing the literature regarding the barriers that hinder teachers from using ICT in the classroom, it is important also to find out the enablers that allow schools to better promote the use of ICT in the classroom (see Table 2.2). A useful survey study was conducted by Scrimshaw (2004) on behalf of BECTA (Jones, 2004) to investigate the enablers to use ICT in the classroom. Scrimshaw (2004) used the recommendations for successful use of ICT from the literature resources and the results of the practitioners' survey answers regarding the enablers that support them to use ICT in the classroom. The enablers were grouped into individual level enablers and whole school level enablers. The individual level enablers were 1) availability of high quality resources, 2) access to own computer, 3) availability of training, and 4) access to software and hardware. The whole school level enablers were 1) on-site technical support, 2) school policies on using ICT across the curriculum, 3) effective timetabling of rooms and equipment, 4) availability of interactive whiteboards in classrooms, 5) support from senior management. There were three additional groups of enablers 1) ensuring awareness, capability, and confidence in using ICT in the classroom (such as observing other teachers, and providing wireless network), 2) ensuring the required access to systems (such as reliable technical backup, and ICT department for lesson support), and 3) emphasising the educational benefits of using ICT (such as helping students to employ technology in their learning, and increasing the amount of hands on time by pupils).

A recent study was conducted by Ertmer et al. (2012) to study how teachers' pedagogical beliefs align with the classroom practices. Ertmer et al. (2012) used a multiple case-study, and data were gathered from twelve k-12 teachers selected based on award-wining technology uses. The results demonstrated that the teachers' beliefs and attitudes had the biggest impact on the success of using technology in the classroom. Ertmer et al. (2012) indicated that despite the existence of technological, administrative, or assessment obstacles, the teachers who held student-centred beliefs tended to use student-centred practices. Moreover, the results reported that the factors such as passion for technology, and support from administrators play key roles in the success of technology integration in the classroom.

Table 2.2: Enablers linked to research studies

Enablers	Research studies
availability of high quality resources	Scrimshaw (2004)
access to own computer	Scrimshaw (2004)
availability of training	Scrimshaw (2004); Alharbi (2012)
access to software and hardware	Scrimshaw (2004)
on-site technical support	Scrimshaw (2004); Starkey (2010)
school policies	Scrimshaw (2004); Starkey (2010)
effective timetabling	Scrimshaw (2004)
availability of interactive whiteboards	Scrimshaw (2004)
support from senior management	Scrimshaw (2004)
teachers' beliefs	Ertmer et al. (2012); Forgasz (2006); Starkey (2010); Alharbi (2012)
teachers' attitudes	Ertmer et al. (2012); Forgasz (2006); Starkey (2010)
passion for technology	Ertmer et al. (2012)
support from administrators	Ertmer et al. (2012); Forgasz (2006)
Availability of ICT skills	Forgasz (2006); Starkey (2010)
Availability of computers	Forgasz (2006)
School support	Forgasz (2006)
availability of shared vision	(Morris, 2010)
financial support	(Morris, 2010)

2.6.4 Enablers and barriers to use ICT in the classroom

It is useful to review not only the studies that addressed the barriers and enablers separately, but also the studies that addressed them together to see the problem from both sides. The paragraphs below provide information about enablers and barriers in more detail.

In Canada, Wood, Mueller, Willoughby, Specht, and Deyoung (2005) conducted a mixed method study (focus groups and survey) to investigate barriers and supports for computer integration. The study involved 54 elementary and secondary school teachers. The survey results indicated that, although teachers used computers at home and school, they lacked confidence with technology. Moreover, teachers' confidence with technology was the only significant variable that affected teachers' use of technology in the classroom; and confidence with technology was predicted by teachers' level of experience (Wood et. al., 2005).

However, results of the focus groups indicated that experienced teachers were not entirely comfortable with technology due to 1) lack of time to practise (such as the increasingly rapid change in innovations), 2) lack of self-efficacy to teach with technology (such as developing a concern for the impact of teaching on the learner), and 3) lack of technical support (Wood et. al., 2005).

Finally, based on the focus groups results, Wood et al. (2005) suggested a framework for examining the successful implementation of technology within a school system. The framework identified the obstacles and incentives for technology integration that were grouped into (1) individual teacher issues (such as familiarity with computers, training, pedagogy, and affect) and, (2) issues with the environment in which the teacher works (such as location, support, curriculum, student characteristics, and teaching level).

In Australia, a study that focused on not only the barriers but also the enablers that affect teachers' use of ICT was conducted by Forgasz (2006) on Victorian secondary mathematics teachers. Data were gathered from 96 teachers in 2001 and 75 teachers in 2003. Teachers were surveyed twice over a 3 year period. Forgasz (2006) reported that the factors that discouraged many mathematics teachers from integrating ICT appeared to be enabling factors for others. However, she found that the most important barriers were access to, or availability of, computers, technical support, and teachers' beliefs about the value of using and not using technology for teaching and learning.

According to Forgasz (2006) institutions and teachers are the major limiting factors for ICT use in teaching practice. It should also be noted that different perceptions towards technology contribute greatly to limiting ICT use in the various schools. The technology skills of both the students and teachers significantly affect their perceptions about the applicability of technology in the learning process. Technology integration is also influenced by the teachers' beliefs about how the overall process will impact on their work. It is because of this reason that many teachers are often resistant since they strongly believe that the traditional teaching methods are more efficient compared to the technology integration. In order to effectively integrate ICT with subjects, sufficient and appropriate changes are required in the curriculum. As a result students will have a chance to enjoy wide and diverse mathematics perspectives. Proper and efficient training sessions should also be provided to the teachers in order to enable integration of technology in their work (Forgasz, 2006).

In the UK, Morris (2010) conducted a small scale study to investigate the main barriers and enablers to ICT skills development and practice. Morris (2010) interviewed six respondents (head teachers and ICT coordinators) working in both primary and secondary schools. He reported that barriers were lack of awareness about new technologies (such as wikis and web 2.0), lack of time to develop ICT skills, and lack of knowledge about how to use technology to support subject teaching. The enablers were availability of a shared vision, financial support, and time for teachers to undertake ICT training (Morris, 2010).

In New Zealand, Starkey (2010) conducted a multiple case study of six digitally able beginning secondary school teachers. The study examined the hindering and enabling factors that affected the integration of digital technologies in the classroom.

Starkey (2010) reported that there were contextual factors and teachers' personal factors that hindered and enabled teachers to use digital technologies in the classroom. The contextual factors were school policies, processes, and structures; teachers' sense of agency; and professional support, while the teachers' personal factors were knowledge, beliefs, and experiences. At the end of the study, Starkey (2010) suggested a supportive context that includes 1) encouraging school policies that allow the use of digital technologies, 2) nurturing teachers' sense of agency, and 3) a mentor that can help with relevant pedagogical content expertise.

It appears that the above studies are consistent with the conclusion that failure to provide enablers to use ICT in the classroom makes them become barriers. Teachers play a major role in the success or failure of an ICT initiative. However, it is interesting to note that the efforts presented by the teacher for integrating ICT in the school curriculum are often fraught with limitations. These limitations are either due to unavailability of software and hardware (Forgasz, 2006), lack of time to plan ICT driven sessions (Lumpe & Chambers, 2001; Kopcha, 2012) or the belief of the teacher about his or her ability to teach using ICT (Albion & Ertmer, 2002; Kopcha, 2012; Gurcay, Wong, & Chai, 2013). These factors are even seen among teachers with exceptional computer skills (Brush, Glazewaki, & Hew, 2008). Therefore, teachers, educational bodies and administrators are looking for strategies that may help them overcome these barriers and integrate ICT effectively in the teaching process (Lim & Khine, 2006; Ertmer & Ottenbreit-leftwich, 2013).

In Kuwait, a research study was conduct by Alharbi (2012) to investigate primary school teachers' perceptions regarding the usefulness of using ICT in the classroom, the barriers that hinder teachers from using ICT in the classroom, and the extent to which ICT is used in teaching. The data were gathered from 14 teachers using interviews. The results demonstrated that most of the teachers had positive beliefs regarding the usefulness of ICT in the classroom. However, the findings indicated that despite the availability of sufficient IT workstations, teachers had limited use of ICT in teaching to enhance the learning and teaching process. This finding was also observed in other research studies on the use of ICT in teaching (Moonen, 2008; Nchunge, Sakwa, & Mwangi, 2012; Reynolds, Treharne, & Tripp, 2003; Robertson, 2002; Rodriguez, Nussbaum, & Dombrovskaia, 2012). The obstacles that limited the teachers from using ICT in teaching were: lack of the projectors, lack of software and hardware, and lack of appropriate professional development programs. Regarding the actual use of ICT in the classroom, the results found that most of the teachers used ICT approximately once a week. Moreover, these uses were limited to the use of PowerPoint for presentation purposes only. Alharbi (2012) emphasized the need for future research in Kuwait that could study teachers' perceptions regarding the use of ICT in the classroom in specific subjects. The current research attempts to fill this gap and focusses on the perceptions of science teachers about their use of ICT at primary school level.

Another study in Kuwait was conducted by Al Sharija, Qablan, and Watters (2012) to explore the perceptions of the teachers, principals, and students about ICT integration in pedagogical activities, and the extent to which ICT is used for learning and teaching activities. The authors used a case study approach to gather the data from three ICT leading Kuwaiti secondary schools. The results demonstrated that ICT was used in the classroom to support just the traditional teaching practices and such use of ICT failed to develop students' problem-solving skills. As observed in other research studies, Al Sharija, Qablan, and Watters (2012) reported that the lack of adequate professional development was the main barrier that hindered the teachers from using ICT to enhance the student academic achievement (Gulbahar & Guven, 2008; Kopcha, 2012; Alsulaimani, 2012). Another barrier that prevented teachers from using ICT was resistance to change as teachers felt that their traditional teaching practices were enough to teach students new concepts. The study indicated that the enablers for teachers to use ICT in teaching were motivating and encouraging the teachers to use ICT in the classroom, and providing appropriate instructions and training.

The present study also explores the perceptions of teachers concerning the use of ICT in teaching to examine if the findings of Al Sharija et al. (2012) and Alharbi, (2012) are generalizable. These studies used only qualitative research methods and focused on few factors that affect use of ICT. The present research includes many other factors in addition to the ones examined by Al Sharija et al. (2012) and Alharbi (2012), and investigates the causal relationships among those factors which is missing in the previous studies

The government of Kuwait has identified a specific need to enhance the use of ICT for learning and teaching, and contributed to further research study in the perception of the teachers (Al Sharija, Qablan, & Watters, 2012). The current research complements the rhetorical reality for teachers' perception of ICT in Kuwaiti schools. The review above shows that there are few studies that were conducted in Kuwait to examine teachers' perceptions regarding using ICT in the classroom. Moreover, these studies used small samples of teachers to conduct their studies and used qualitative methods, which means that the results cannot be generalised. Also, previous research emphasized the need for further research studies that explore teachers' perceptions in specific subjects regarding the use of ICT in teaching (Alharbi, 2012). This study specifically focuses on science and the use of ICT in primary school uses mixed method approach to examine the factors affecting teachers' use of ICT in the classroom and the causal relationship between these factors.

An accurate understanding of the influence of the factors that affect teachers' use of ICT may be useful to enhance the teachers' teaching process. Moreover, there may also be factors associated with each other that may influence use. Therefore, a comprehensive approach wherein psychological factors are simultaneously considered is required. To provide an adequate explanation, there is a need for a study that investigates the factors that affect teachers' actual use and affect in each other, and how those factors are associated with actual use.

2.7 Summary

This chapter reviewed previous literature on teachers' use of ICT, in order to understand their current use. The first section discussed the adoption of ICT in schools. The second section addressed the integration of ICT in the classroom. The third section discussed the actual use of ICT in the classroom. In this section, research showed that teachers used ICT for communication and administration tasks more than using it in the classroom to enhance the learning and teaching process. The fourth section discussed research that has been done on science teachers' use of ICT in the classroom. Section five addressed the aspects that influence teachers' use of ICT. In this section, research showed that there were many factors that affected teachers' use of ICT in the classroom. Some studies identified the barriers that hinder teachers from using ICT in the classroom while others investigated the enablers that promote teachers' use of ICT in the classroom. However, these studies have not used a comprehensive theoretical approach to understand how these factors influence each other and how these factors influence the teachers' decisions to use ICT. Therefore, the following chapter will review the relevant theoretical frameworks that describe teachers' perceptions about ICT use.

Chapter 3: Conceptual Framework

This chapter reviews the conceptual framework that would help to explore the factors that affect science teachers' use of Information and Communication Technology (ICT), and actual use of ICT from teachers' perspectives. The Technology Acceptance Model (TAM) (Davis, 1989) has been selected as the baseline model on which a research model of science teachers' use of ICT in teaching, the Information and Communication Technology Acceptance Model (ICTAM) was developed for this study. Section one of the review below includes literature that deals with the characteristics of the TAM, and section two reviews the studies that adapted TAM and other theories as theoretical frameworks for approaches to explaining behaviour regarding the use of technology. Section three reviews the educational research studies that used TAM as the theoretical framework to predict the behaviour of teachers. In order to develop the conceptual framework, ICTAM, in this study, it is important to identify the factors that affect teachers' use of ICT in teaching. Therefore, section four reviews different approaches to adaptation of the TAM by various studies that used TAM as a theoretical framework and the factors that these studies have included in order to explain teachers' intentions and behaviour.

3.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by Davis in 1989 to explain the behaviour of a user with regards to using information technologies. The model was developed on the basis of a psychological theory known as the theory of reasoned action (TRA), which was developed by Ajzen and Fishbein (1969) to predict human behaviours. Figure 3.1 shows the constructs of TRA.

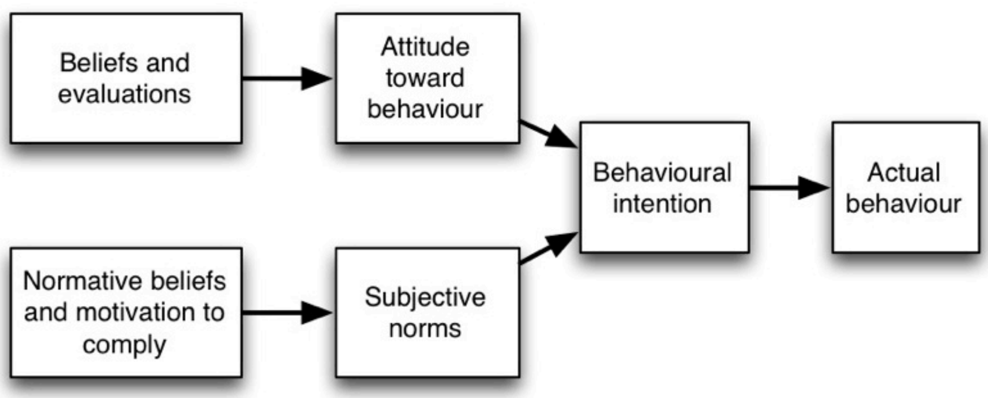


Figure 3.1: Theory of Reasoned Action (Ajzen & Fishbein, 1969)

The Theory of Reasoned Action (TRA) has two categories of beliefs, attitude towards behaviour and subjective norms that affect the actual behaviour of a user (Sagar, 2006). Later, Davis (1989) developed the Technology Acceptance Model based on the Theory of Reasoned Action (TRA). According to TAM, there are two key predictors of use, perceived ease of use (PEoU) and perceived usefulness (PU), which are linked to attitudes (AB). Further, the model also has a dependent variable known as behavioural intention (I), which is closely linked with actual behaviour (B) (Figure 3.2).

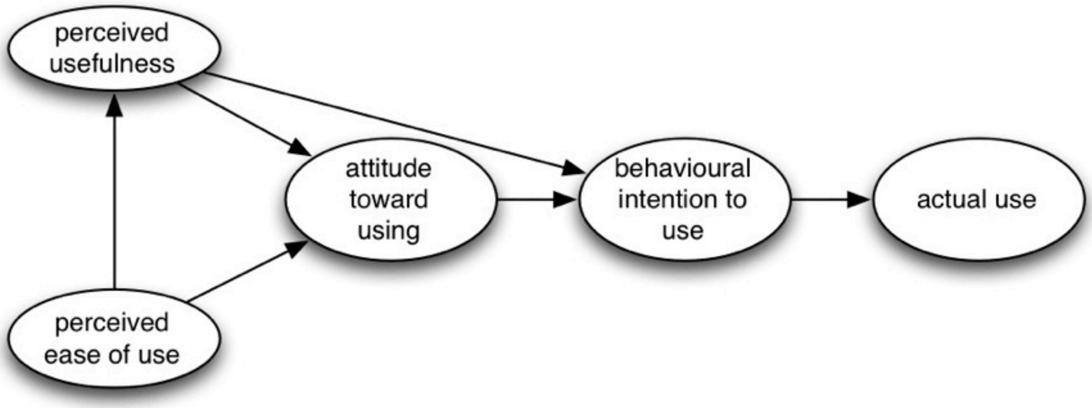


Figure 3.2: Technology Acceptance Model (Davis et al., 1989)

According to TAM (Davis, 1989; Davis et al., 1989), the intention to use a particular technology is generally determined by the perceived usefulness of the technology to the person and the perceptions of ease of use that the person may have. Perceived usefulness includes the beliefs of a person, wherein he or she thinks that through the use of a particular system his or her work performance may improve. On the other hand perceived ease of use means that the person believes using the technology would result in less effort to accomplish the job. These two beliefs influence a user's attitude toward using the system, which is defined as the degree of a user's positive or negative feelings about using the system. Further, attitude (AB) and usefulness (PU) influence the user's behavioural intention (I), which is defined as the strength of the user's intention to use the system in the future. Moreover, intention (I) predicts actual behaviour (B) which is defined as a user's frequency of use of a system.

Originally, TAM was developed to explain the behavioural intention regarding adopting and using an information system (Davis, 1989; Davis, 1993). The model has been used widely to find out about the level of technological innovation adoption, particularly in the field of computers and information systems (Liu, 2010; Yuen & Ma, 2008; King & He, 2006; Spacey et al., 2004; Gao, 2005; Shin, 2009a, b). Venkatesh (2000) attributed applying TAM in his investigation of employees' use of information technologies to the fact that TAM has become widely regarded as the most valid model for predicting the acceptance of information technology due to its understanding and simplicity. Moreover, in his comparative study, Mathieson (1991) compared two models, technology acceptance model and theory of planned behaviour. He found that, despite TAM and TPB both explaining the variances, TAM is easier to apply when predicting IS usage in many situations. However, Mathieson (1991) found that TAM does not include all the constructs that appear in TPB. Therefore, Mathieson et al. (2001) extended TAM to include an additional construct (perceived resources) that did not appear in the original model. This construct came from the concept that resource barriers (i.e. lack of time, funding, equipment and support) may hinder the use of technology. Matheison et al. (2001) applied the extended TAM (Figure 3.3) to predict management accountants' voluntary use of the bulletin board system (BBS). The findings of this study were that perceived resources significantly affected behavioural intention and ease of use.

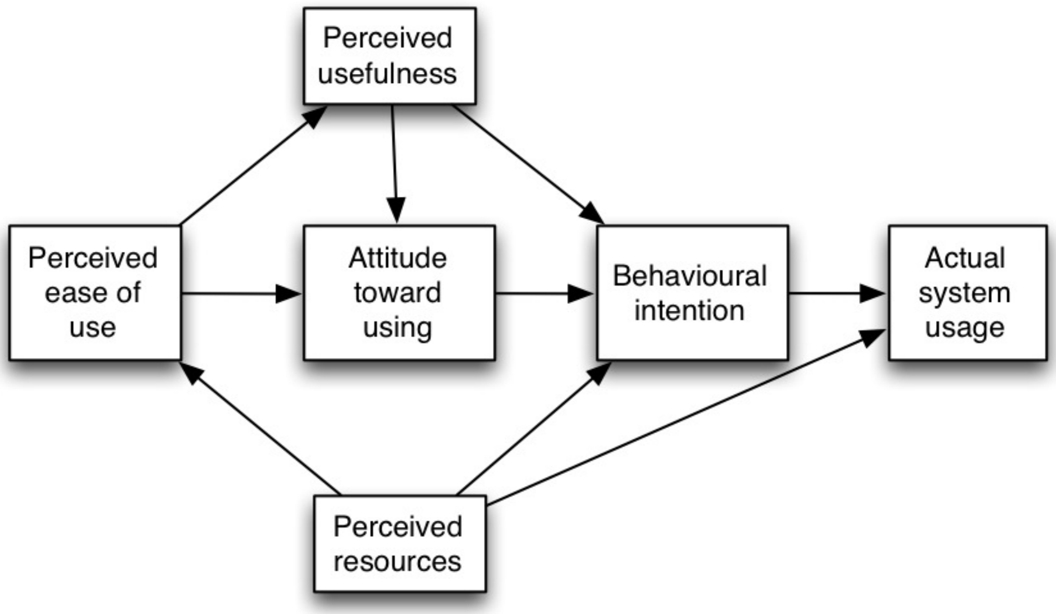


Figure 3.3: The extended Technology Acceptance Model (Mathieson et al., 2001, p. 87)

Despite TAM having been widely applied in business systems, its use in education systems is considered limited (Teo, 2009). Also, the results of the studies that have been conducted in business cannot be generalized into the educational sector. The main reason is that the general users and educational users react in a different manner when it comes to accepting technology. It has been found that teachers have more autonomy over their decision to choose a particular technology as compared to general users (Gong et al., 2004; Teo, 2009). Teachers' use of technology depends on how technology can support their educational objectives, not like business users who experience peer competition that affects their choices (Hu, Clark, & Ma, 2003 cited by Teo, 2009). Researchers who have applied TAM as a theoretical framework in educational contexts found that TAM was an appropriate model to predict a person's acceptance of a technological innovation (Hasan & Ahmad, 2007; Liu, 2010). However, researchers determined inclusion of additional variables to be important determinants on perceived ease of use, perceived usefulness, and behaviour toward using the system (Chau, 1996; Nair & Da, 2012; Teo, 2010; Teo, 2010a: b). Table 3.1 present a summary of the main features of TAM.

Table3.1: Summary of the main features of the TAM

Summary	Features of TAM
Description	Explains the behaviour of a user to ICT based on the theory of reasoned action (TRA) to predict human behaviour
Issues	The intention to use ICT is determined by the perceived usefulness of the technology and the perception of ease of use.
Strengths	Used widely to explain the behavioural intention regarding the implementation of ICT, easy to apply, applicable to different situation.
Validity	Most widely regarded as a valid model for predicting the acceptance of ICT due to its understanding simplicity.
Limitations	• Does not include all the constructs that are important for examining teachers' use of ICT.

	• Limited application beyond business settings into education.
Extensions	Contains additional constructs: Computer self-efficacy, subjective norms, and external barriers
Applications of the extended TAM	• Implementation of the computer and information systems. • Management accountants and their use of a voluntary BBS. • Implementation of systems. • Teachers and their use of technology
Potential for this study	Appropriate theoretical framework for educational contexts to predict teachers' acceptance of ICT

3.2 Adaptability of the Technology Acceptance Model (TAM)

In the area of IT acceptance, some researchers developed unique models to explain IT adoption behaviours. Others adapted the technology acceptance model (Chau & Lai, 2003; Davis, 1993; King & He, 2006; Liu, 2010; Lu et al., 2003; Sturb, 2009; Yuen & Ma, 2008) and other theories to elaborate a unique model for identifying the factors that affect people's acceptance and adoption of particular IT. The following section describes studies that apply or adapt theories that were used to explain or predict behaviour related to IT adoption.

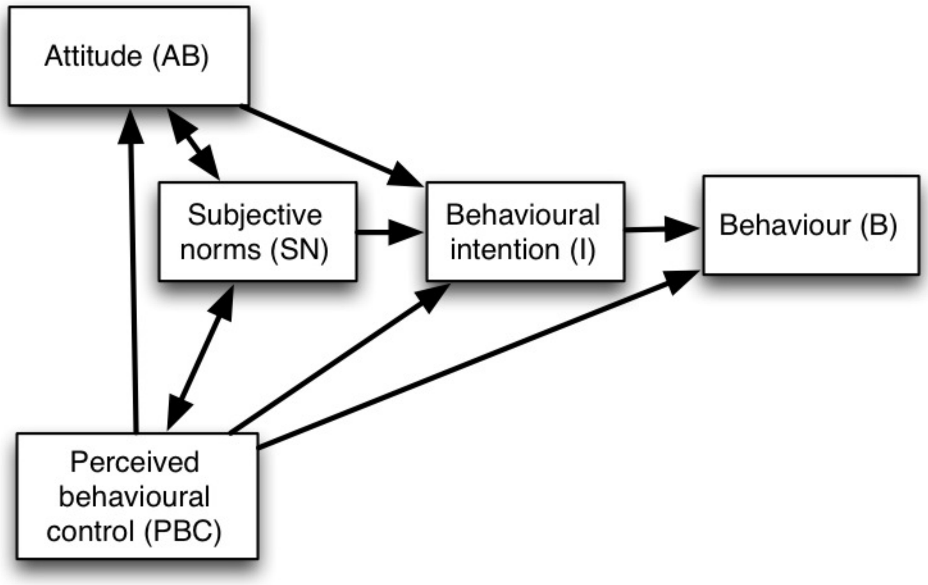


Figure 3.4: Theory of planned Behaviour (Ajzen, 1985)

One of these theories that were developed from other theories is a model proposed by Ajzen (1985). Ajzen developed the theory of planned behaviour (TPB) by adding an additional predictor, perceived behavioural control, to the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980) (discussed earlier in this chapter). The theory of planned behaviour (TPB) consisted of three factors, attitude towards the behaviour, subjective norms, and perceived behavioural control that predict behaviour and intention as shown in Figure 3.4. Ajzen (1985) demonstrated that TPB is a parsimonious model that can predict behaviours. Also, all the variables of the TPB have significant effect on intention and behaviour. Despite this model having shown a wide validity, it is not used in the current study because it lacks the availability of the constructs of perceived usefulness and perceived ease of use

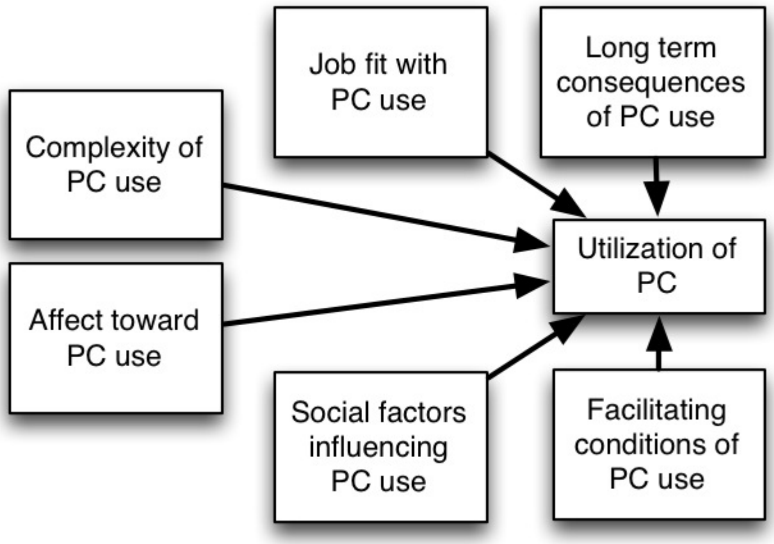


Figure 3.5: Factors influencing the utilization of personal computers (Adapted from the model proposed by Triandis, 1980) (Thompson, Higgins, & Howell, 1991, p. 131)

Another model that was developed from a different theory is that proposed by Thompson, Higgins, and Howell (1991). The model of PC utilization (Figure 3.5) was developed to explain the utilization of the personal computer (PC). This model was developed by using a subset of Triandis' (1980) theory of attitudes and behaviour. The model of PC utilization determined that the constructs, long-term consequences of PC use, job fit with PC use, complexity of PC use, affect toward PC use, social factors influencing PC use and facilitating conditions for PC use have a direct effect on the Utilization of PC. The constructs, job fit, complexity, and affect, are almost equivalent to TAM's perceived usefulness, perceived ease of use, and attitude, respectively (Thompson et al., 1991). Further, facilitating conditions and social factors influencing PC use are equivalent to perceived behavioural control and subjective norms respectively. The results of testing this model showed that social factors, complexity, job fit, and long-term consequences have significant effects on PC use. Thompson et al. (1991) used technical support as one type of facilitating condition. They pointed out that others should have been included due to their importance. The decision in the current study not to use this model as the base for developing a model was due to the focus of this model on studying only the direct relationships between the constructs long-term consequences of PC use, job fit with PC use, complexity of PC use, affect toward PC use, social factors influencing PC use and facilitating conditions for PC and the construct utilization of PC.

In turn, one of the theories that adapted TAM is a model proposed by Venkatesh (2000) who added determinants of perceived ease of use: integration control, intrinsic motivation, and emotion into the technology acceptance model (TAM) (see Figure 3.6). He tested the proposed model by surveying 246 employees in three different organizations. The results indicated that the model was strongly supported. Venkatesh reported that control (conceptualized as computer self-efficacy and facilitating conditions), motivation (conceptualized as playfulness), and emotion (conceptualized as anxiety) played a major role in forming ease of use about a new system. This extended TAM is not suitable for the current study, because the additional constructs were added to the model to examine their relationship with only perceived ease of use.

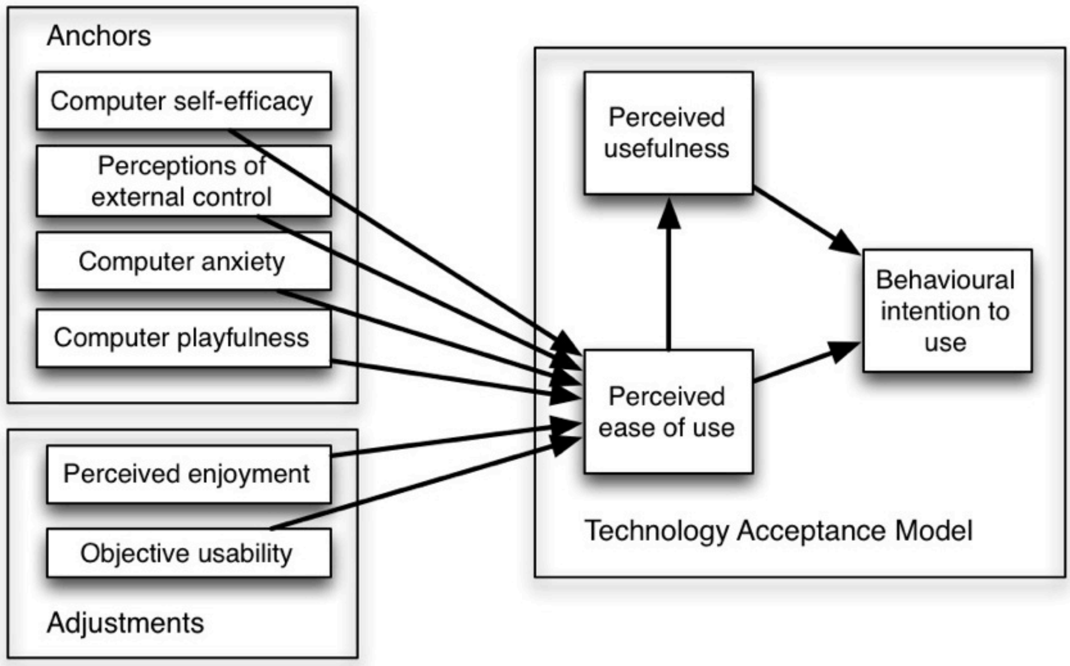


Figure 3.6: Theoretical Model of the Determinants of Perceived Ease of Use (Venkatesh, 2000)

In addition, Venkatesh and Davis (2000) adapted a new model called TAM2 by extending the technology acceptance model (TAM). TAM2 consisted of social processes (subjective norms, voluntariness and image), and cognitive instrumental processes (job relevance, output quality, result demonstrability, and perceived ease of use) (see Figure 3.7). Venkatesh and Davis (2000) tested TAM2 in four organizations that used four different systems. The use of these systems was at a voluntary level in two organizations; and at a mandatory level in two organizations. The results from testing TAM2 indicated that the model was supported, and the new constructs significantly affected user acceptance. This model is not suitable for the current study, because the new added variables and their relationship with the TAM variables are suitable for general users not school teachers.

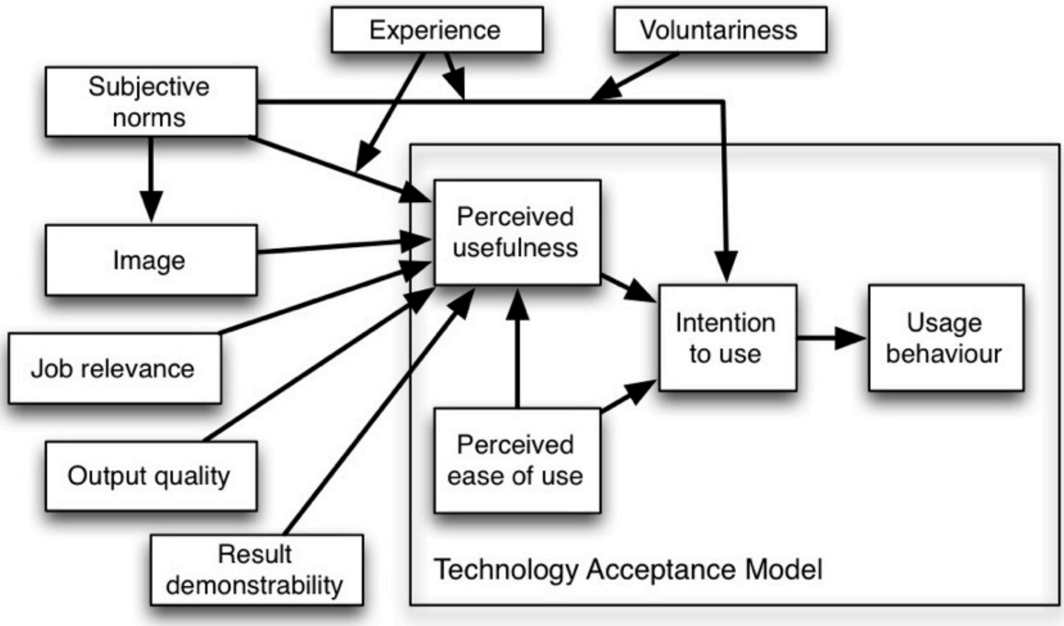


Figure 3.7: Technology Acceptance Model 2 (TAM2) (Venkatesh and Davis, 2000)

Another example of adaptation was a model proposed by Venkatesh, Morris, Davis, and Davis (2003) to explain use behaviour. They developed the unified theory of acceptance and use of technology based on eight models: the technology acceptance model, the theory of reasoned action, the theory of planned behaviour, the model of PC utilization, a model combining the technology acceptance model and theory of planned behaviour, the motivational model, the innovation diffusion theory, and the social cognitive theory (see Figure 3.8). Venkatesh et al. (2003) tested the proposed model by surveying 215 employees from four organizations using four different systems. The results from testing UTAUT demonstrated that the model was strongly supported and all the relationships between the variables were significant.

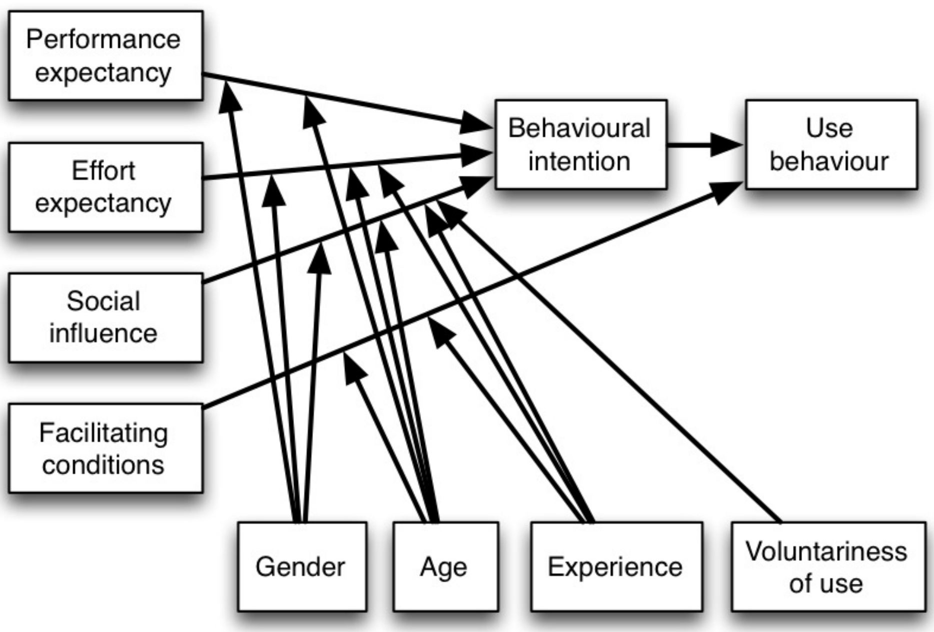


Figure 3.8: Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, 2003)

A theory that adapted TAM was developed by Venkatesh and Bala (2008). They proposed a model called TAM3 to study managers' decisions about interventions for effective use of IT (Venkatesh & Bala, 2008). Venkatesh and Bala (2008) adapted TAM3 by combining TAM2 (Venkatesh & Davis, 2000) and the model of the determinants of perceived ease of use (Venkatesh, 2000) (see Figure 3.9). The authors tested TAM3 by surveying 171 managers from four different organizations using new information technologies. The results indicated that TAM3 was a comprehensive and parsimonious model. Also, the results demonstrated that the constructs, ease of use, subjective norms, image, and result demonstrability were the key predictors of perceived usefulness. This model is not suitable to be adapted for the current study as it is a complex model and adding new variables to it will make it more complex.

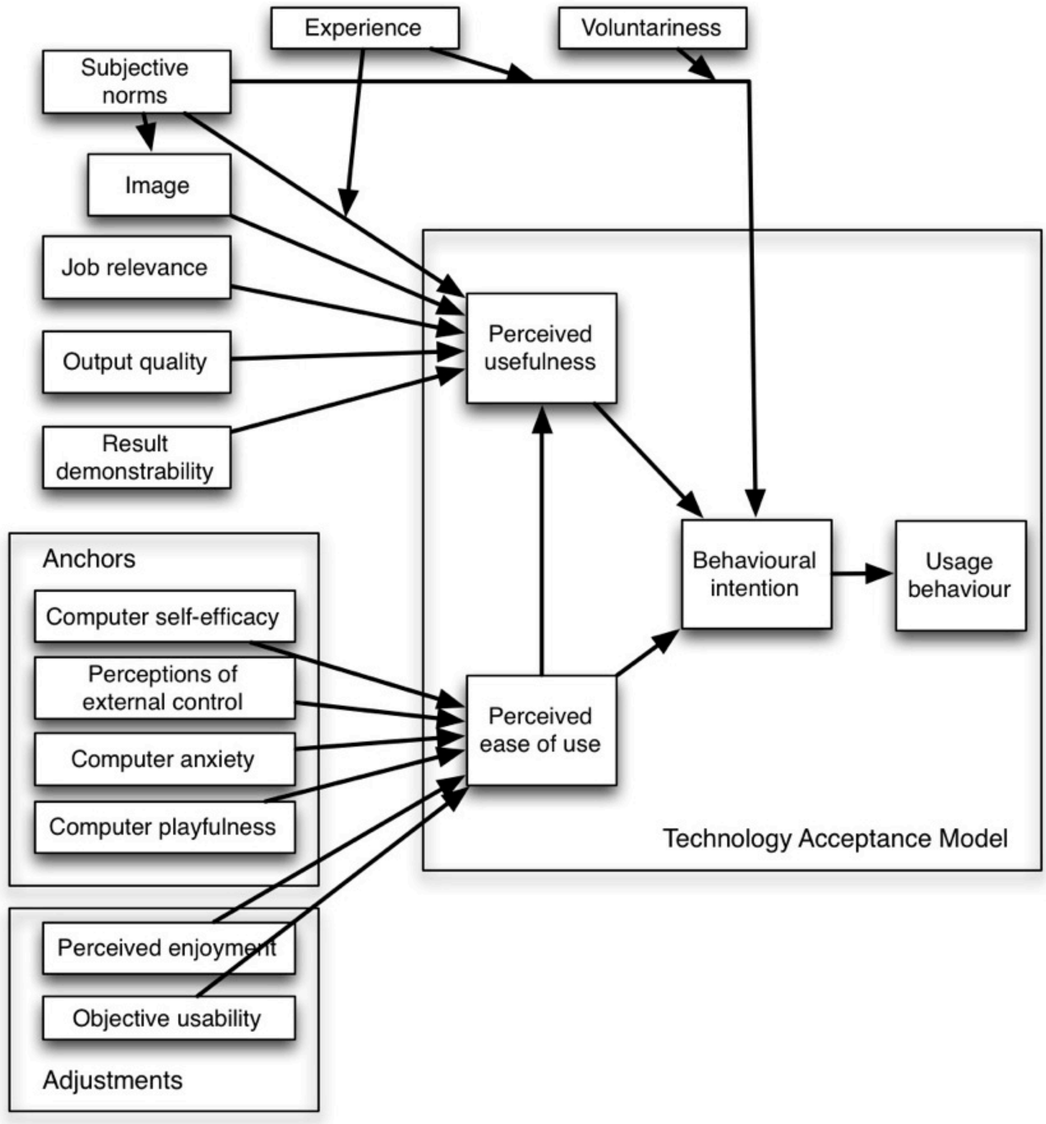


Figure 3.9: Technology Acceptance Model 3 (TAM3) (Venkatesh & Bala, 2008)

3.3 Application of Technology Acceptance Model (TAM) in educational research studies

This section discusses the application of the Technology Acceptance Model and related theories in education. Most of the research studies that were conducted in the educational sector demonstrated the validity and reliability of TAM and other theories and provided empirical support for those models in predicting intention and explaining behaviour. Moreover, some of the studies that extended TAM and other theories were also valid and reliable models. The paragraphs below provide descriptions of these studies.

3.3.1 Models tested on practising teachers

There are researchers who tested the adapted or adopted models on teachers. The paragraphs below discuss these studies in details.

Applying models that are originally developed to be tested on general users into educational users is not a new issue. A study that was conducted more than a decade ago by Hu, Clark, and Ma (2003) focused on developing a model that can predict school teachers' use of ICT. Hu et al. (2003) extended the technology acceptance model by adding new variables: job relevance, compatibility, computer self-efficacy, and subjective norms (see Figure 3.10). The authors surveyed 130 teachers attending a training program on PowerPoint. The results of testing the proposed model demonstrated that the model was a reasonably good fit with the data. Hu et al. (2003) reported that job relevance significantly affected perceived usefulness. Also, computer self-efficacy significantly affected perceived ease of use. Moreover, compatibility had a significant effect on perceived ease of use. In addition, perceived ease of use had limited effect on teacher acceptance at training. On the other hand, subjective norms had an adverse effect on perceived usefulness.

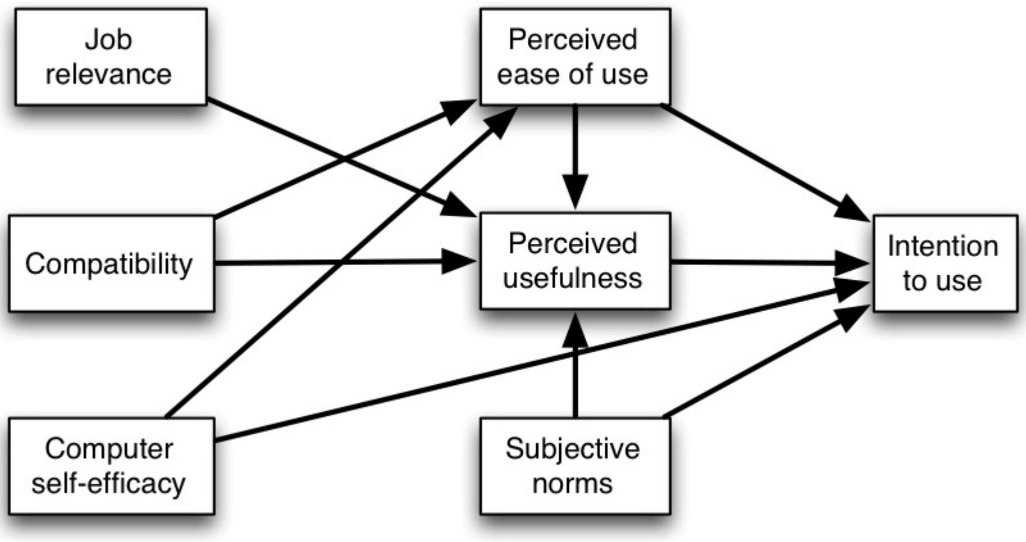


Figure 3.10: Extended Technology Acceptance Model (Hu, et al., 2003)

In addition, Vannatta and Banister (2009) designed a teacher technology integration survey (TTIS) to assess teachers' technology practices by measuring teachers' beliefs and behaviours towards using technology in the classroom. TTIS comprises six constructs, risk taking behaviour and comfort with technology; perceived benefits of using classroom technology; beliefs and behaviours about classroom technology use; technology support and access; teacher technology use for instruction, instructional support, communication and facilitation of student technology use. They reported that the perceived benefits construct (which is equivalent to perceived usefulness) and beliefs and behaviours were significant predictors of teachers' use of technology in the classroom. This result predicted that perceived usefulness is an important factor for explaining the use of technology.

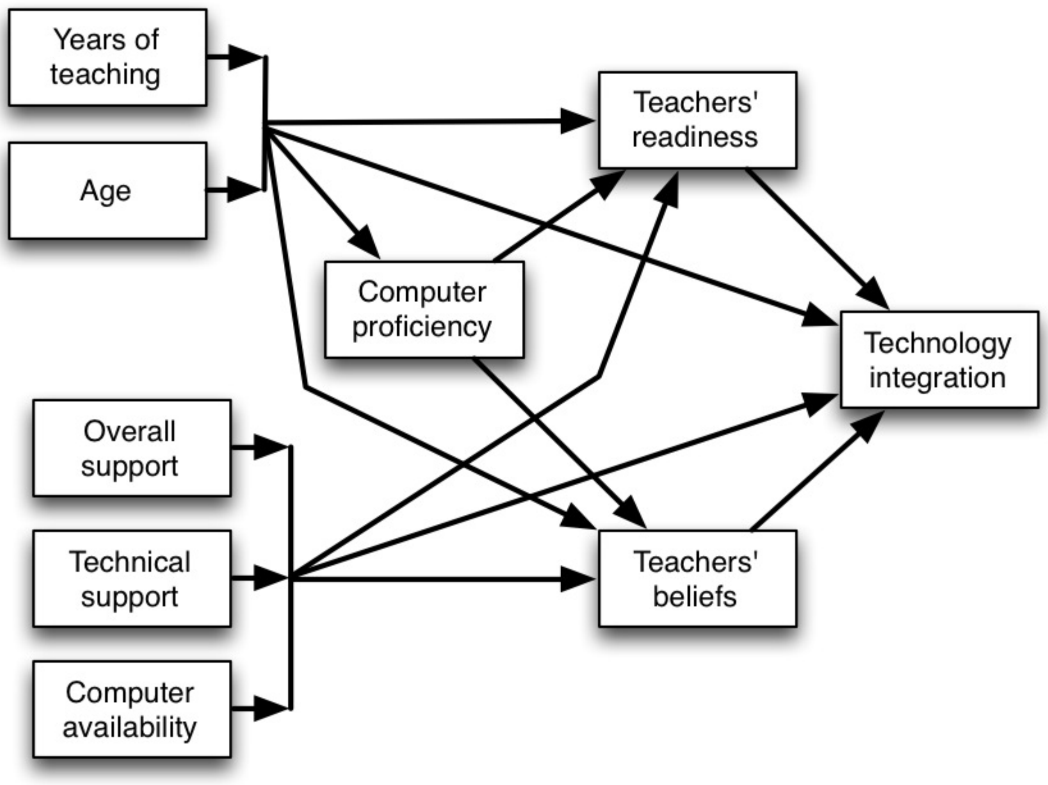


Figure 3.11: Proposed model (Inan & Lowther, 2010)

Moreover, Inan and Lowther (2010) developed a model to investigate the factors affecting teachers' technology integration in K-12 classrooms (Figure 3.11). The model was tested in Tennessee public schools among 1,382 teachers. The model consisted of nine variables: years of experience, age, overall support, technical support, computer availability, computer proficiency, teachers' beliefs, teachers' readiness, and technology integration. Inan and Lowther (2010) reported that the model was supported by the findings, and all the relationships between the variables were significant. However, the construct teachers' readiness (which is equivalent to self-efficacy to use technology in teaching) was the key predictor of the technology integration.

Wu, Ghang, and Guo (2008) developed a model by combining three theoretical paradigms: technology acceptance model, social cognitive theory, and task technology fit. The study involved 226 Taiwanese middle school science teachers. The model consisted of the constructs: perceived fit, perceived usefulness, perceived ease of use, computer self-efficacy, and intention (see Figure 3.12) (Wu et al., 2008). They reported that perceived usefulness and computer self-efficacy were key determinants of science teachers' intention to integrate technology. Perceived fit significantly affected both perceived usefulness and perceived ease of use. Also, computer self-efficacy was a distinct antecedent of perceived fit, perceived ease of use, and intention. However, ease of use negatively impacted perceived usefulness. Over all, the proposed model was supported by the findings (Wu et al., 2008). At the end of the study Wu et al. (2008) recommended future research studies to investigate the mediators between behavioural intention and actual usage.

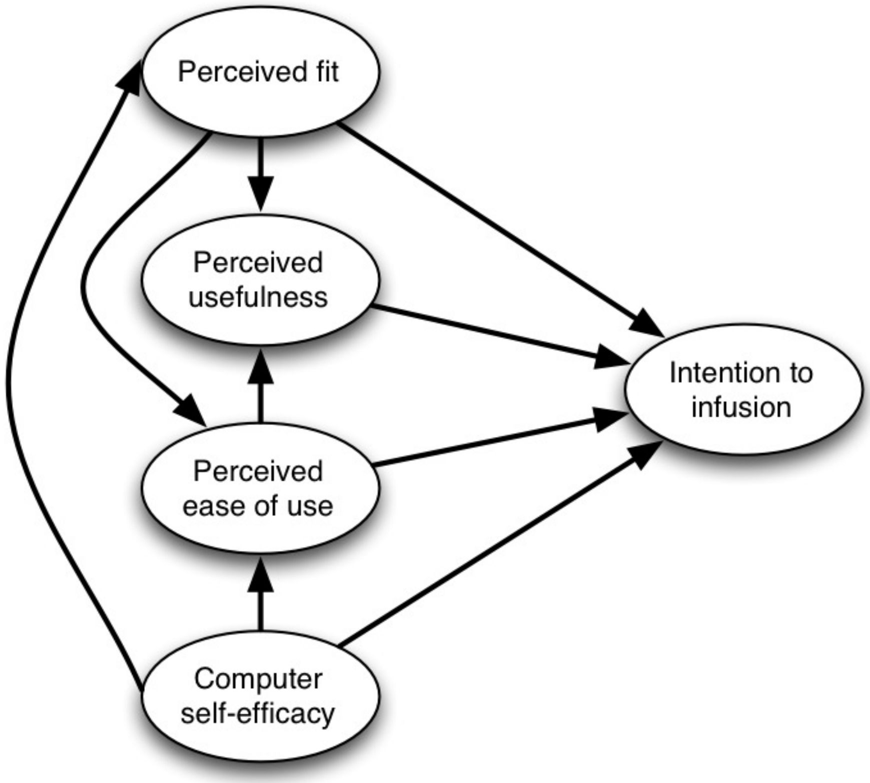


Figure 3.12: A model developed by Wu et al. (2008)

In Turkey, Summak, Baglibel, and Samancioglu (2010) adopted the technology readiness index (TRI) that was developed by Parasuraman (2000) to explain the technology readiness of the primary school teachers. TRI consisted of four dimensions that assess the level of readiness: optimism, innovativeness, discomfort, and insecurity. The authors surveyed 207 teachers from 11 different schools. They reported that the teachers' readiness level was moderate. The results demonstrated that the teachers' optimism was higher than their innovativeness and insecurity was higher than discomfort. These results indicated that teachers were not highly ready for technology. At the end of the study, Summak et al. (2010) recommended that the ministry of education and school administrators should provide activities for the teachers that lead to increasing their technology-readiness.

In Virginia, Holden and Rada (2011) adapted TAM to incorporate perceived useability, technology self-efficacy, and computer self-efficacy (see Figure 3.13). The authors assessed the model by surveying 99 K-12 teachers in two rural schools. Holden and Rada (2011) reported that the proposed model explained more variance and was more impactful compared to TAM variables. Moreover, the results demonstrated that all the relationships between the variables were significant. However, technology self-efficacy was more beneficial to TAM than computer self-efficacy in explaining teachers' use of technology. The difference between the constructs, computer self-efficacy (Compeau & Higgins, 1995) and technology self-efficacy (Holden & Rada, 2011), was that the first evaluated confidence in using the computer generally, while the latter evaluated confidence toward successfully using technology itself. At the end of their study, Holden and Rada (2011) indicated the need for new research studies that examine the effect of technology self-efficacy on acceptance of technology of different populations and different technologies. Also, they recommended that future researchers should study the external barriers to understand user issues and find out ways to improve the assessed technology.

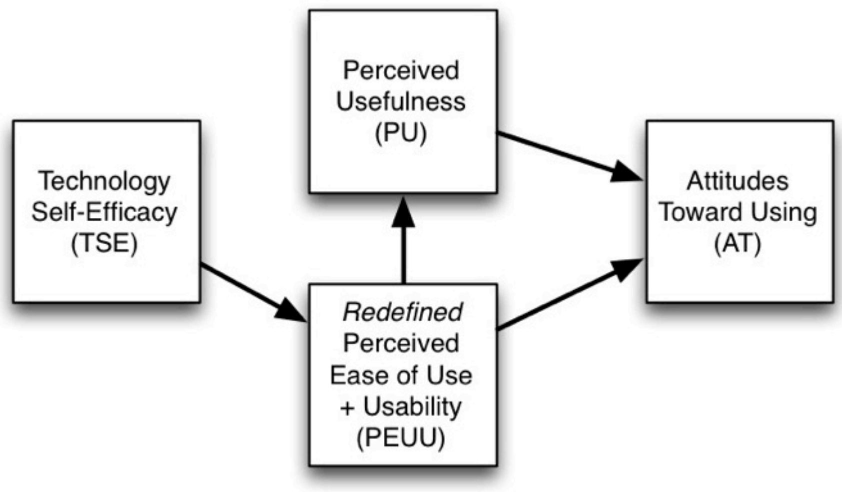


Figure 3.13: Adapted Technology Acceptance Model (Holden & Rada, 2011)

In Malaysia, Phua, Wong, and Abu (2012) extended TAM by adding the construct perceived enjoyment. The authors developed the model to evaluate home economic teachers' use of Internet (see Figure 3.14). Phua et al. (2012) demonstrated that the proposed model had a good fit to data. Moreover, the results indicated that most of the HE teachers had a strong behavioural intention to use Internet in teaching. In addition, the findings demonstrated that Internet attitude, perceived usefulness, perceived ease of use, and perceived enjoyment had strong positive relationships with behavioural intention. Finally, there were recommendations from the authors of the study for researchers. The authors used Pearson's r correlation to analyse their data and recommended that future researchers use structural equation modelling to analyse the data to identify the causal relationships between variables of the study (Phua et al., 2012).

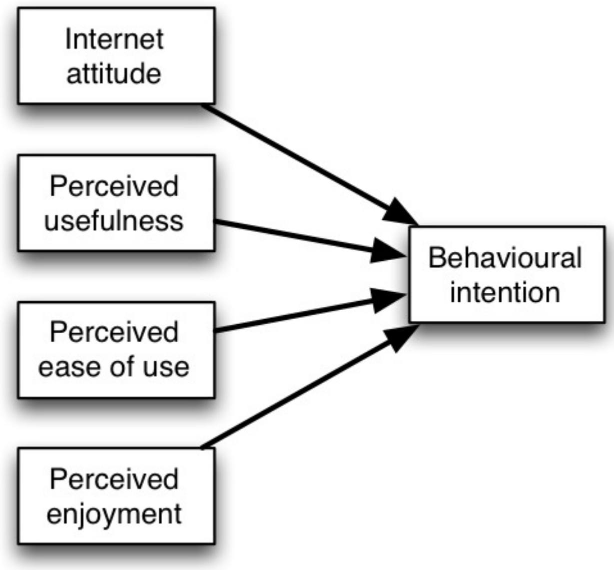


Figure 3.14: Modified Technology Acceptance Model (Phua et al., 2012)

In India, Nair and Das (2012) used TAM to assess high school mathematics teachers' acceptance of technology. The study involved 195 teachers who responded to a questionnaire survey. The authors reported that the model was strongly supported. Moreover, the results demonstrated that perceived ease of use had significant effect on attitude toward use and perceived usefulness. However, perceived usefulness had insignificant impact on attitude toward use. The author of this study recommended the need to extend TAM with the inclusion of variables related to technology and subject domain which can have direct or moderated effect on teachers' intention to use technology.

A recent study in Malaysia was conducted by Moses, Wong, and Bakar (2013) to determine the antecedents of attitude towards laptop use among the mathematics and science teachers. Moses et al. (2013) applied TAM to predict teachers' acceptance of laptops (see Figure 3.15). Survey questionnaire was used to conduct the study, and data were gathered from 292 science teachers and 278 mathematics teachers. The results indicated that perceived usefulness had significant effect on attitude toward laptop use. However, perceived ease of use had insignificant impact on attitude toward laptop use. At the end of the study, Moses et al. (2013) determined that there is a need for qualitative studies to gain more in-depth understanding of the antecedents of attitude toward use among teachers.

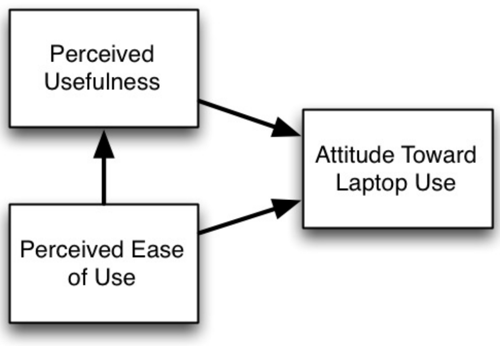


Figure 3.15: A model developed by Wong and Bakar (2013)

3.3.2 Models tested on pre-service teachers

Research studies also have tested the adoption and adaptation of models on pre-service teachers. Below are discussions of these studies.

In the USA, Chen (2010) proposed a model to investigate the factors affecting pre-service teachers' use of technology to support student-centred learning. This study used a survey research method, and involved a convenience sample of 206 pre-service teachers. The model consisted of the constructs: context, training, value, efficacy, and use (see Figure 3.16). Chen (2010) demonstrated that the proposed model had a moderate fit to data. Moreover, the results indicated that self-efficacy to use technology had the strongest impact on use of technology. In addition, context (support, time, access) had a significant effect on use of technology. Furthermore, the construct training had significant effect on the construct value (equivalent to usefulness) and self-efficacy. However, the construct value had weak effect on use of technology. Chen (2010) indicated at the end of his research the need for future studies that examine social and contextual factors that affect teachers' decision making.

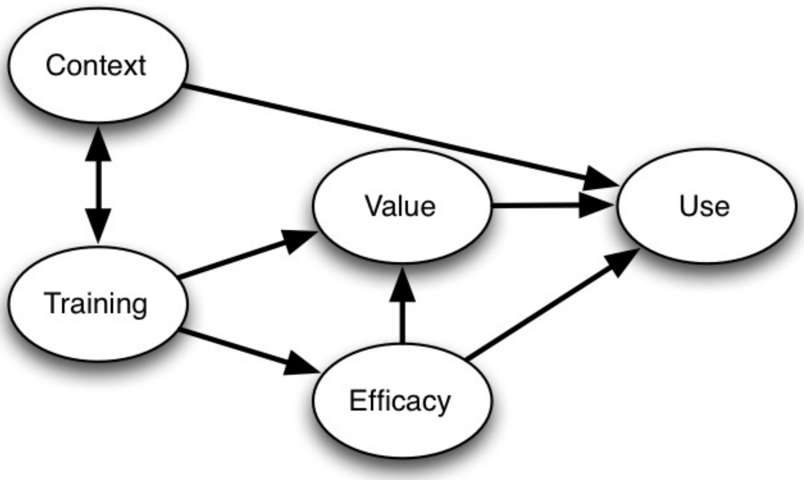


Figure 3.16: A model illustrating pre-service teachers' use of technology for student-centred learning (Chen, 2010)

In Malaysia, Teo (2010b) used TAM to assess its cross-cultural validity for pre-service teachers on a Malaysian sample. The study involved 198 pre-service teachers who completed a survey questionnaire. The results demonstrated that there was construct and factorial validity. Technology acceptance model for pre-service teachers (TAMPST) was a reliable and valid model to predict pre-service teachers' acceptance of technology. Moreover, all the relationships between variables were significant. Finally, Teo (2010b) indicated the need for future studies that test the validity and reliability of TAM involving different cultures for pre-service and practising teachers.

Teo and Schaik (2012) compared four models: TAM, TRA, TPB, and an integrated model (see Figure 3.17) to test which model best helps to explain pre-service teachers' intention to integrate technology. The authors surveyed 429 pre-service teachers from a teacher training institute in Singapore. The results indicated that the four models had a good fit to data and there was not any difference in the explanatory power between the examined models. As a final point, Teo and Schaik

(2012) indicated the need for research to study additional factors that impact on the intention to use technology.

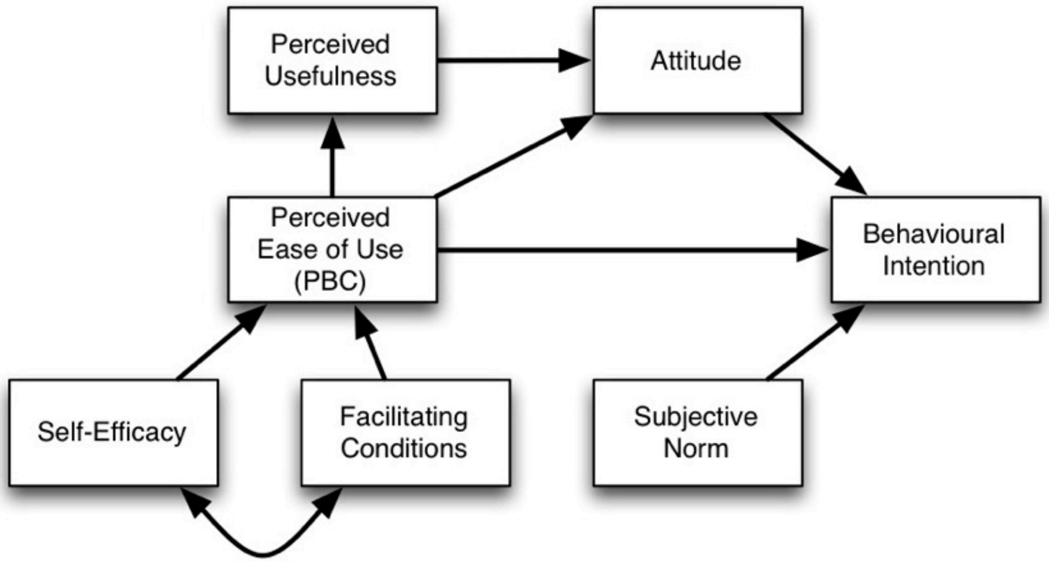


Figure 3.17: Integrated Model (Teo & Schaik, 2012)

Another study in Malaysia was conducted by Wong, Osman, Goh (2013) to measure student teachers' behavioural intention to use technology. The authors adopted TAM to test its ability in predicting Malaysian student teachers' integration of their technology in teaching and learning. Data were gathered from 302 participants who responded to the survey questionnaire. The results indicated that TAM had a good fit to data. Moreover, all the relationships between the constructs of TAM were significant. Wong et al. (2013) indicated at the end of their study the need for future research studies that test TAM on practising teachers. Also, they indicated the need for using a larger sample so the results can be better generalized to a whole population.

These above studies of IT use are indications that developing unique models is appropriate. To be more specific, the review above shows that TAM is applicable to be adopted or adapted in different cultures as it has proven its ability in measuring teachers' acceptance of ICT. However, the review shows that there is no study conducted in the Middle East and especially in Kuwait. Moreover, all the studies discussed above used a single method which was a survey questionnaire. In addition, most of these research studies indicated the need of the inclusion of new variables into TAM to test their importance in predicting teachers' acceptance of technology. Therefore, to provide a better understanding of the behavioural characteristics of teachers' use of ICT, an extension of TAM was applied in the current study.

3.4 Extension of Technology Acceptance Model

After reviewing the literature regarding the models that were used to predict actual behaviour regarding the use of technology, TAM was the best model to be used in the current study due to its simplicity, understandability, and wide validity in different contexts in general and in education in particular. In the context of this study, it is important to elaborate a unique TAM adaptation that is appropriate for predicting science teachers' use of ICT by focusing on particular factors that affect teachers' use of ICT, because "TAM's fundamental constructs do not fully reflect the variety of user task environments" (Moon & Kim, 2001, p. 218). In order to elaborate a unique adaptation of TAM, three additional factors were added into the TAM model for the current study: 1) extension of self-efficacy to use ICT in teaching, 2) perceived external barriers, and 3) subjective norms, as predicting science teachers' acceptance of ICT by adding self-efficacy to use ICT, subjective norms, and perceived external barriers have not been investigated yet. By adding those three variables to TAM the new proposed model covers most of the factors that were discussed in the literature and were demonstrated to impact teachers' use of ICT in the classroom.

3.4.1 Inclusion of subjective norms into the TAM

Subjective norms are defined as a person's perceptions about social pressure to perform or not to perform behaviour (Ajzen, 1991). Marcinkiewicz and Regstad (1996) in their study of teachers' use of computers found that subjective norms were important factors in explaining teachers' use of computers. They identified that the people who were considered as important for teachers were principal, colleagues, pupils, and professional bodies. Venkatesh and Davis (2000) indicated that an individual would support an idea that was already favoured by other influential people. Mulkeen (2003) found in their study that teachers would use ICT in their classes if there was support from principal and ICT coordinator.

There are many researchers who investigated the effect of subjective norms on use of technology. For example, Salleh and Albion (2004) investigated mathematics and science teachers' intentions and use of ICT in teaching. The authors adopted TPB to predict teachers' acceptance of ICT. Salleh and Albion (2004) used a survey method, and the data were gathered from 563 secondary school teachers in Brunei. The results indicated that the model had a good fit to data. Moreover, the results reported that teachers' subjective norms significantly predicted teachers' intentions. In addition, attitude toward using ICT had significant effect on intention. However, Perceived behavioural control had insignificant impact on intention.

Yuen and Ma (2008) explored teachers' acceptance of e-learning. They adapted TAM by adding additional constructs: subjective norms and self-efficacy (see Figure 3.18). A total of 152 teachers participated in the study by responding to the survey questionnaire. The results demonstrated that ease of use had significant effect on intention. Moreover, subjective norms had a significant effect on teachers' perceived usefulness and perceived ease of use. In addition, self-efficacy had significant impact on perceived ease of use. Furthermore, ease of use had significant influence on perceived usefulness and intention. However, self-efficacy, subjective norms, and perceived usefulness had insignificant effect on intention. Also, self-efficacy had insignificant effect on perceived usefulness.

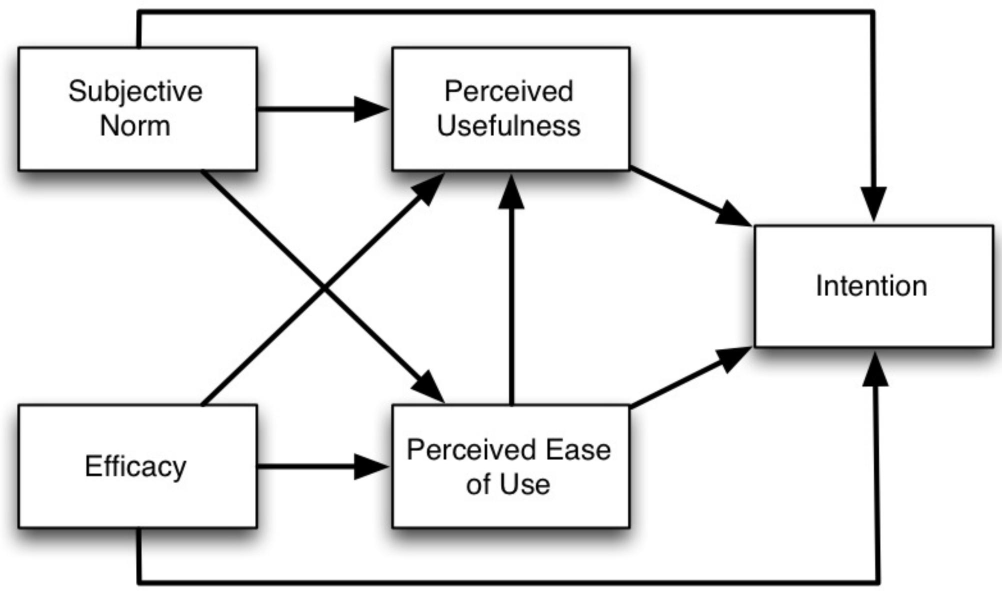


Figure 3.18: Extended Technology Acceptance Model (TAM) (Yuen & Ma, 2008, p. 232)

Mathieson (1991) in his comparative study (discussed earlier in this chapter) found that TAM did not include all the constructs that appear in TPB. Thus, subjective norms did not appear in the TAM but were added in the current study because of their importance to predict the behaviour. However, the previous studies used a single-item measure for subjective norms, which contributed to the weak relationship between subjective norms and other variables.

Later, Marcinkiewicz (1994) used multiple-item scales to improve the power of subjective norms measures. He conducted a study to examine the relationship between teacher variables to teachers' adoption of computer use. He added the variable subjective norms to the variables computer use, perceived relevance, and self-competence to study its importance in affecting teachers' decisions to use computers. Subjective norms were identified through the impact of principal, colleagues, student, and profession. The data were gathered from 138 elementary school teachers. The results demonstrated that subjective norms had significant effect on teachers' use of computer. As mentioned above the previous research studies used single-item scale for subjective norms that was demonstrated to be a weak scale. However, Marcinkiewicz (1994) developed a multiple-item scale that showed validity. Thus, the instrument developed by Marcinkiewicz (1994) was used in the current study.

3.4.2 Inclusion of perceived external barriers into TAM

Perceived external barriers are defined as a person's beliefs about the external barriers that may hinder him/her from integrating technology. Many researchers identified the external barriers that hinder teachers from using ICT.

Most teachers as well as the school administration are looking for the right strategies that would help in overcoming the barriers to teachers related to ICT use. Researchers have attempted to find some of these strategies that would help in integrating ICT by managing the barriers. Hunter (2001) for instance, wrote a report on a research project conducted over a period of two and a half years, and 100 teachers in a pre-k-12 school complex participated in the study. He examined the strategies that were applied by US forces schools in Venice, Italy. These strategies dealt with issues such as lack of professional development as an important barrier for integrating ICT. The results indicated that there were two kinds of obstacles that hindered teachers from using ICT in teaching: systemic obstacles, and local obstacles. The systemic obstacles were: curriculum, administrative commitment, technical support, teacher time, teacher work load, technology infrastructure, professional development, technology policies, equipment access, and assessment capacities. Whereas, the local obstacles were: administrative turnover, school schedules, electrical system, and facilities (Hunter, 2001).

Moreover, Fox and Henri (2005) conducted a study to explore the impact of IT on teaching practices in Hong Kong schools. The study used surveys, group discussions, and follow-up individual interviews for data collection. The results indicated that the teachers used IT to support their teacher-centred approach. This study demonstrated that restricted impact of IT on the teachers' practices was due to the existence of the following barriers: lack of leadership, inflexibility of the curriculum and assessment processes, lack of time, and lack of professional development programs. Therefore, with the increase in the use of ICT in schools, it is also imperative to identify as well as manage the barriers that are hindering teachers from integrating ICT in their teaching modules (Fox & Henri, 2005).Also, Hew and Brush (2007) found that resources (i.e. lack of technology, lack of access to technology, lack of time, and lack of technical support), institution (i.e. leadership, time-tabling structure, and lack of technology plan), skills (i.e. lack of adequate professional development programs), and assessment, are external barriers that affect ICT use by k-12 teachers (Discussed in more detail in Chapter 2).

Many researchers have added some of these external barriers into the TAM to explore its relationship with other variables. Mathieson et al. (2001) added a perceived resources construct and studied its effect on management accountants' use of an IT system. They defined perceived resources (PR) as a human's beliefs about the availability of personal and organizational resources (i.e. expertise, the hardware, the software, and funding) needed to use an IS (Mathieson et al., 2001). They maintained that this construct is equivalent to the construct perceived behavioural control (PBC), which is one of theory of planned behaviour's (TPB) constructs (Mathieson, 1991). The findings of this study were that perceived resources significantly affected behavioural intention and ease of use.

In educational research, Teo (2009) developed a model by adding facilitating conditions (equivalent to perceived external barriers (EB)), technology complexity, and self-efficacy into the TAM to study its influence on teachers' use of technology (see Figure 3.19). Teo (2009) defined facilitating conditions as the environmental factors (i.e. skills training, information or materials available; and administrative support) that affect a user's desire to perform a job. Teo (2009) gathered data from 475 pre-service teachers in Singapore using a survey questionnaire. The results demonstrated that the model had a good fit. In addition, the constructs perceived usefulness, attitude toward use, and self-efficacy had direct significant influence on use of technology, whereas, ease of use, technology complexity, and facilitating conditions had indirect influence on use of technology.

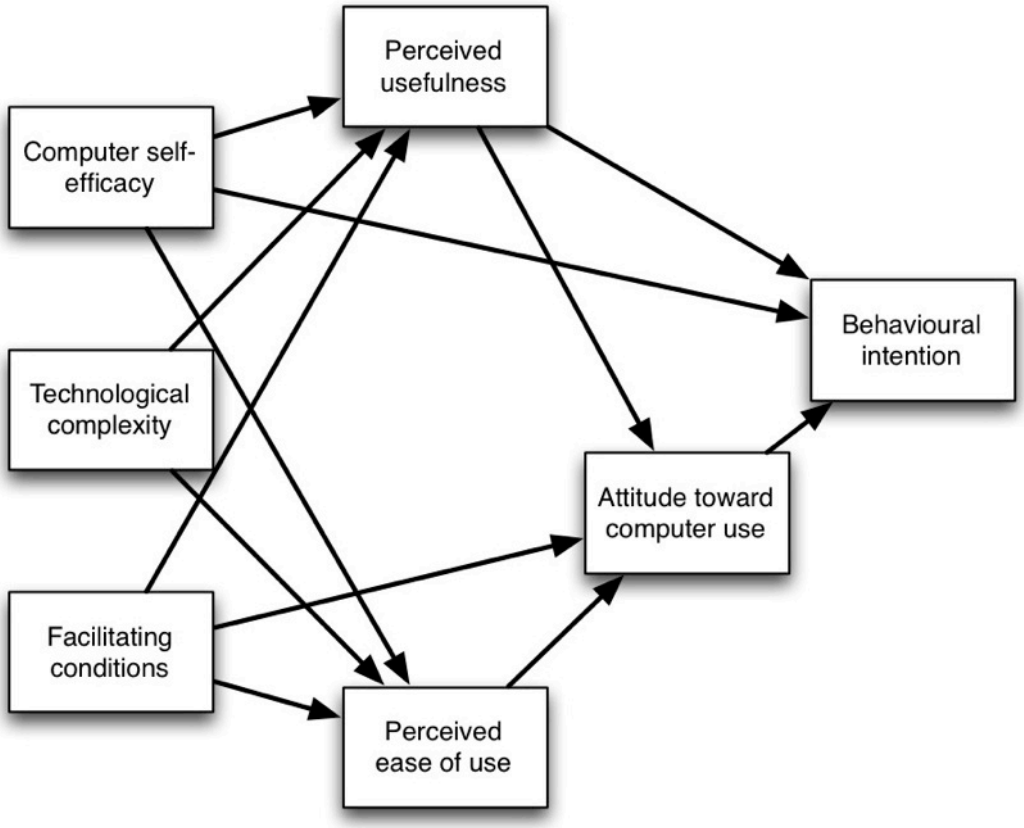


Figure 3.19: Extended Technology Acceptance Model (TAM) (Teo, 2009, p. 305)

In addition, Teo (2010a) extended TAM by adding the factors facilitating conditions (equivalent to perceived external barriers (EB)), technological complexity, and subjective norms to examine pre-service teachers' attitudes to computers (see Figure 3.20). The study employed a survey questionnaire and 239 pre-service teachers participated in the study. The results demonstrated that the model had a good fit to data. In addition, all the factors were significant determinants of pre-service teachers' attitudes to computers, whereas, perceived usefulness was the key determinant of attitude toward using computer. At the end, Teo (2010a) suggested the need for studies that test practising teachers. Also, he indicated that there could be studies that test whether there are discrepancies between perceptions about using technology and actual use, to find out the factors that clarify the gap. Moreover, Teo (2010a) indicated the need to test the TAM model in other cultures as TAM was originally developed in Western culture.

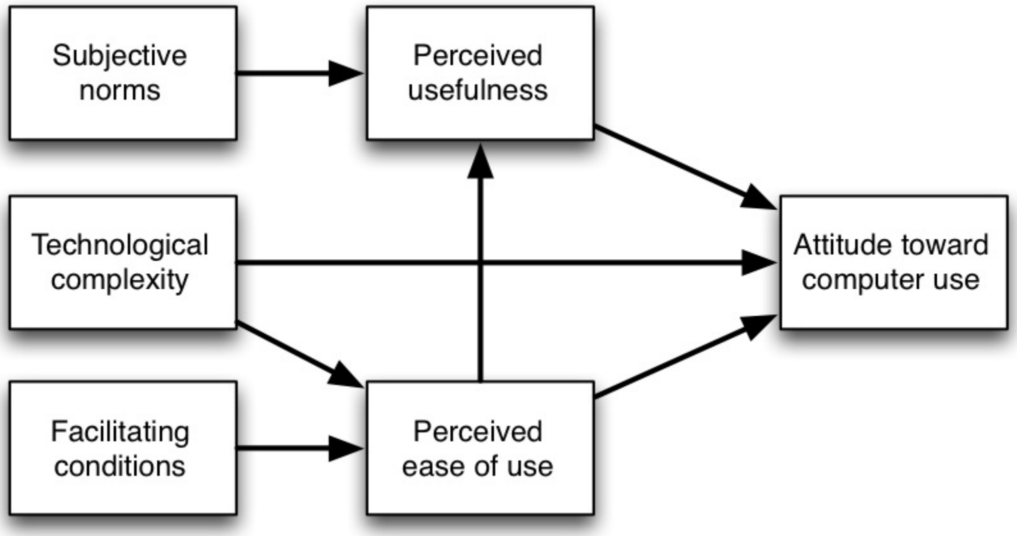


Figure 3.20: Extended Technology Acceptance Model (Teo, 2010a)

Teo (2011) developed a new model by combining three models TAM, TPB, and UTAUT. The proposed model consisted of the variables: perceived usefulness, perceived ease of use, subjective norms, perceived behavioural control, facilitating conditions (equivalent to perceived external barriers (EB)), attitude toward use, and behavioural intention to use (see Figure 3.21). Teo (2011) tested the proposed model on 592 teachers in Singapore by using survey method. The results indicated that the model had a good fit to data. Moreover, the results demonstrated that perceived usefulness, attitude toward use, and facilitating conditions had significant effect on behavioural intention. However, subjective norms had insignificant effect on behavioural intention. Teo (2011) indicated at the end of his study the need to study these variables in different cultures to identify the culture-invariant variables that impact teachers' intention to use technology in teaching and learning.

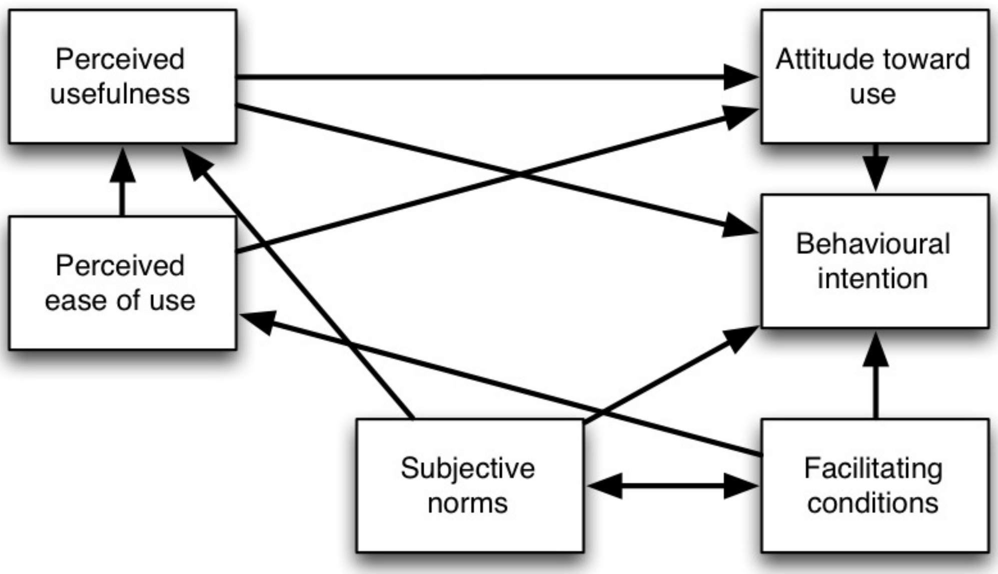


Figure 3.21: A model developed by Teo (2011)

Many research studies identified the external barriers that have influence on teachers' use of ICT but how those external barriers may be related to other influencing factors that also have influence on teachers' behaviour has been focused on the resources. So, it is imperative to examine the other external barriers and their influence on behaviour toward the use of ICT. Hew and Brush (2007) reviewed the literature in detail and provided information about most of the external barriers that affected teachers' integration of ICT. The current study gathered all those external barriers that were examined and validated by different researchers and made them the items of the construct perceived external barriers. Therefore, extension of perceived external barriers into the TAM was applied in the current study.

3.4.3 Inclusion of self-efficacy to use ICT in teaching into the TAM

Social cognitive theory and self-efficacy (Bandura, 1982) have been applied to explain teachers' use of technology (Yuen & Ma, 2008). Bandura (1986) defined self-efficacy as "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has, but with judgments of what one can do with whatever skills one possesses" (p. 391).

Researchers (Igbaria & Iivari, 1995) have found that the quality of the computer usage experience plays a major role in establishing self-efficacy beliefs. This shows that it is the kind of computer usage experience among teachers that matters most rather than the mere usage of a computer technology (Pamuk & Peker, 2009). This similarity in results over 14 years confirmed the potential effect of usage experience on self-efficacy beliefs. Thus, a positive experience acquired while using computers would increase the self-efficacy levels, whereas a negative incident would reduce the level of self-efficacy. Therefore, in order to develop computer self-efficacy in educators, it is important to provide them with a positive computer usage experience. It is important to break this usage barrier and once the teachers are provided with a positive computer usage experience, it would be easier to build computer self-efficacy.

Compeau and Higgins (1995), in their study about understanding the impact of self-efficacy on computing behaviour, defined computer self-efficacy as the person's beliefs about his/her capability to use a technology. Albion (2001) suggested that teachers displaying low computer self-efficacy in teacher education programs are likely to develop problems with integrating technology in their day-to-day teaching module once they start their own classes. Therefore, self-efficacy has been considered as a major factor to understand the adoption and usage of computers especially among teachers.

However, teachers' skills in the personal use of computers do not necessarily mean that they possess the ability to use computers in their teaching. Self-efficacy for teaching relies more on performance as compared to possession of skills. Self-efficacy to use ICT is attained when teachers get the right kind of training and consequently are able to adeptly integrate it into their teaching practices (Pamuk & Peker, 2009). Again, when teachers are able to use ICT in teaching, then it is evident that efficacy in ICT will have been achieved as both students and teachers will attain their desired outcomes. Many researchers found that teachers who had positive constructivist beliefs (Kersaint et al., 2003) and self-efficacy beliefs (Govender &

Govender, 2009) used computers in their teaching (Pamuk & Peker, 2009). The researchers also found that self-efficacy beliefs about teaching with computers affected teachers' technology-related practices (Lumpe and Chambers, 2001).

For instance, in the USA, Lumpe and Chambers (2001) developed an instrument to evaluate teachers' context and self-efficacy beliefs about the integration of technology in the classroom. The study involved 307 teachers who were participating in a technology professional development program. The results indicated that context and self-efficacy beliefs were significant predictors of technology integration for teaching and learning practices.

Anderson and Maninger (2007) conducted a study to investigate changes in pre-service teachers' abilities, perceived self-efficacy for integrating technology, value beliefs, and intentions to use technology for teaching. The data were gathered from 76 pre-service teachers using pre- and post-course survey questionnaires while taking an introductory educational technology course. The results demonstrated that pre-service teachers' abilities, self-efficacy for integrating technology, and value beliefs increased over the course of the semester. Moreover, the results indicated that there were significant relationships between the variables: self-efficacy for integrating technology, value beliefs, and intentions. In addition findings of the study demonstrated that perceived self-efficacy for integrating technology was the best predictor of pre-service teachers' intention about technology integration in teaching.

Govender and Govender (2009) conducted a study to explore the relationship between teachers' self-efficacy beliefs relating to their competence and attitude toward using technology. Data were gathered from 1222 teachers using survey questionnaire. The results demonstrated that attitude toward using technology, attributes of computers, and competency levels of using technology were related to teachers' self-efficacy beliefs.

Many research studies have added computer self-efficacy into TAM to examine its effectiveness in predicting ICT integration. For example, Yuen and Ma (2008) conducted a research study to develop a model to understand teachers' acceptance of e-learning technology (discussed earlier in this chapter). They expanded TAM with subjective norms and self-efficacy (see Figure 3.18). The results indicated that computer self-efficacy had a direct positive effect on perceived ease of use.

In another study, Teo (2009) examined the level of technology acceptance by pre-service teachers (discussed earlier in this chapter). Teo expanded the TAM with the constructs, technological complexity, computer self-efficacy, and facilitating conditions (see Figure 3.19). The results indicated that computer self-efficacy had a significant direct effect on perceived usefulness and behavioural intention (the strongest effect in the study).

All the above research studies that extended TAM used the computer self-efficacy instrument that was developed by Compeau and Higgins (1995) to examine the effect of computer self-efficacy in predicting the behaviour. However, it is important to examine the effect of self-efficacy to use ICT in teaching on behaviour. Thus Anderson and Maninger's (2007) (discussed earlier in this chapter) instrument "perceived self -efficacy for integrating technology" was utilized in the current study.

3.5 Proposed Information and Communication Technology Acceptance Model

The current study developed a model to predict science teachers' use of ICT. The Technology Acceptance Model (TAM) was used as a core framework for analysis while additional constructs were added in order to find a better model to understand science teachers' use of ICT. The literature above tested most of the factors that impact the actual use of technology. However, there is no research study that included all these factors in one model. Therefore, the factors mentioned in the literature above that have been demonstrated as important factors that impact teachers' use of ICT in teaching, were included in the proposed model. The proposed Information and Communication Technology Acceptance Model (ICTAM) consisted of eight constructs: actual use of ICT, behavioural intention, attitude toward using ICT in teaching, perceived usefulness, perceived ease of use, self-efficacy to teach using ICT, subjective norms, and perceived external barriers as shown in Figure 3.22. The establishment of relationships between these variables was according to the review of the literature.

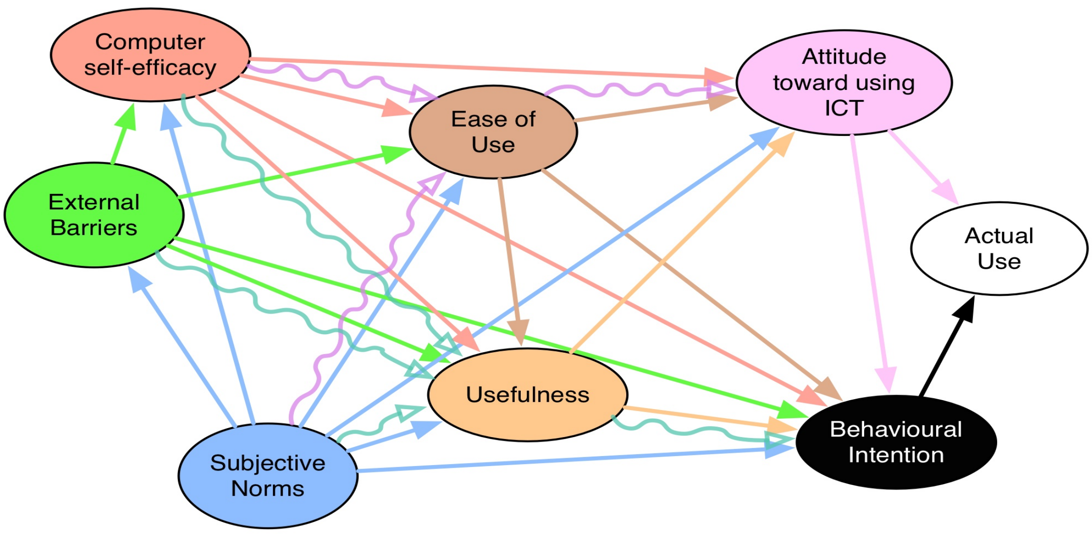


Figure 3.22: Proposed ICT Acceptance Model (ICTAM, modified from Davis et al., 1989, p. 985)

Sold arrows represent direct relationships

Wiggly arrows represent the mediation role of ease of use

3.6 Summary

Chapter three has presented the proposed Information and Communication Technology Acceptance Model and the constructs selected to build this model. Section 3.1 provided information about the Technology Acceptance Model that provided the base of the proposed model. In Section 3.2 the adaptability of TAM and other theories was addressed. Section 3.3 provided information about application of the technology acceptance model in educational research studies. In Section 3.4 the extension of TAM was discussed. Section 3.4.1 presented the inclusion of subjective norms into TAM. In Section 3.4.2 the inclusion of perceived external barriers into TAM was addressed. Section 3.4.3 discussed the inclusion of self-efficacy to integrate ICT in teaching into TAM. Finally, Section 3.5 was allocated to present the constructs of the proposed model, and the relationship between these constructs.

Chapter 4: Methodology

This chapter is concerned with the way in which the data were collected to answer the research questions. The following sections describe the research methods of the current study. Section 4.1 provides an overview of the research design. The quantitative analysis procedures are dealt with in Section 4.2. Section 4.3 presents the methodology applied for qualitative analysis. The ethical considerations for the research are considered in Section 4.4. Finally the summary of the chapter is provided in Section 4.5.

4.1 Research design

Creswell (2009) indicated that a mixed method approach can be conducted when the study has both types of data, quantitative and qualitative, together and these types of data jointly provide a better understanding of the research problem than either type by itself. The current study employed a mixed method approach which is highly recommended by researchers for its advantages (Greene, Caracelli, & Graham, 1989; Ryan & Bernard, 2000; Johnson & Christensen, 2008). This approach allows confirming or corroborating the results of all the methods that are used in the study. It also examines a phenomenon under investigation using multiple perspectives. Moreover, it provides more flexibility and validation of data when compared to using a single method approach (McIntosh, 1998). Using a mixed method approach adds a depth to the findings not possible with a single methodology (Johnson & Onwuegbuzie, 2004).

Questionnaire surveys and semi-structured interviews were employed in this study in a triangulated approach for collecting and integrating two types of data on the same research problem (Johnson & Christensen, 2008). The advantage of triangulation was to improve the integrity of the research findings (Hess-Biber, 2010). A mixed methods design was used in the current study to gain a more complete understanding of social phenomena (Leahey, 2007) as shown in Figure 4.1.

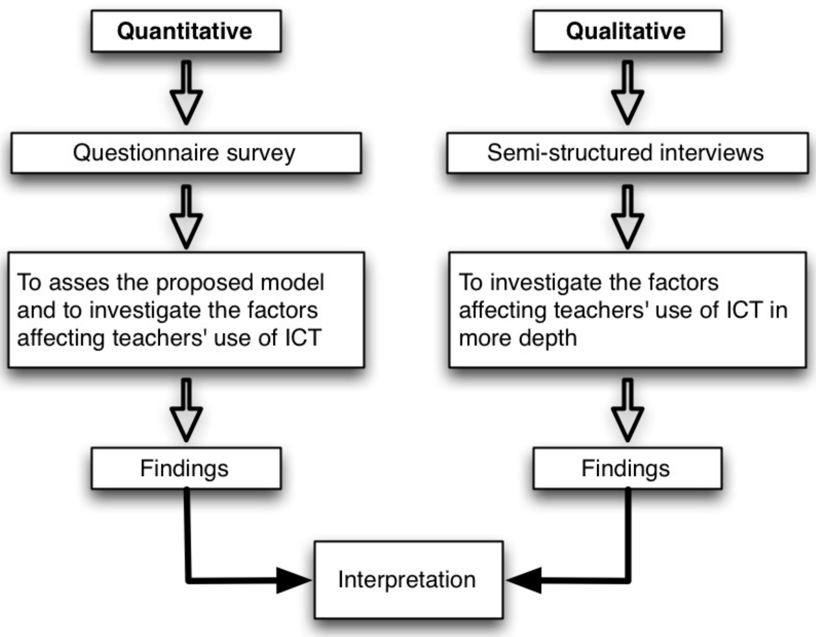


Figure 4.1: Mixed method research design

4.2 Quantitative data

This study employed a survey research method that has been frequently used in research on information technology and computer use (Thompson et al., 1991; Davis, 1989; Teo, 2009). A survey research method is particularly useful for generating quantitative data that can be used to establish the basis for wider generalization (Creswell, 2009). A questionnaire is administered to obtain participants' responses to questions about the variables under investigation in a relatively short timeframe (Stangor, 2011). The data collected on these variables can then be studied using appropriate statistical procedures (Donald, 2009). The questionnaire administered in the current study was used to collect data with which to test statistical relationships among the constructs of the modified TAM model, ICT Acceptance Model (ICTAM) that underpin this research study: ***perceived usefulness (PU), perceived ease of use (PEoU), attitude (A), intention to use (I), subjective norms (SN), self-efficacy for using ICT in teaching (SE), external barriers (EB), and use of ICT (B)*** as shown in Figure 4.2

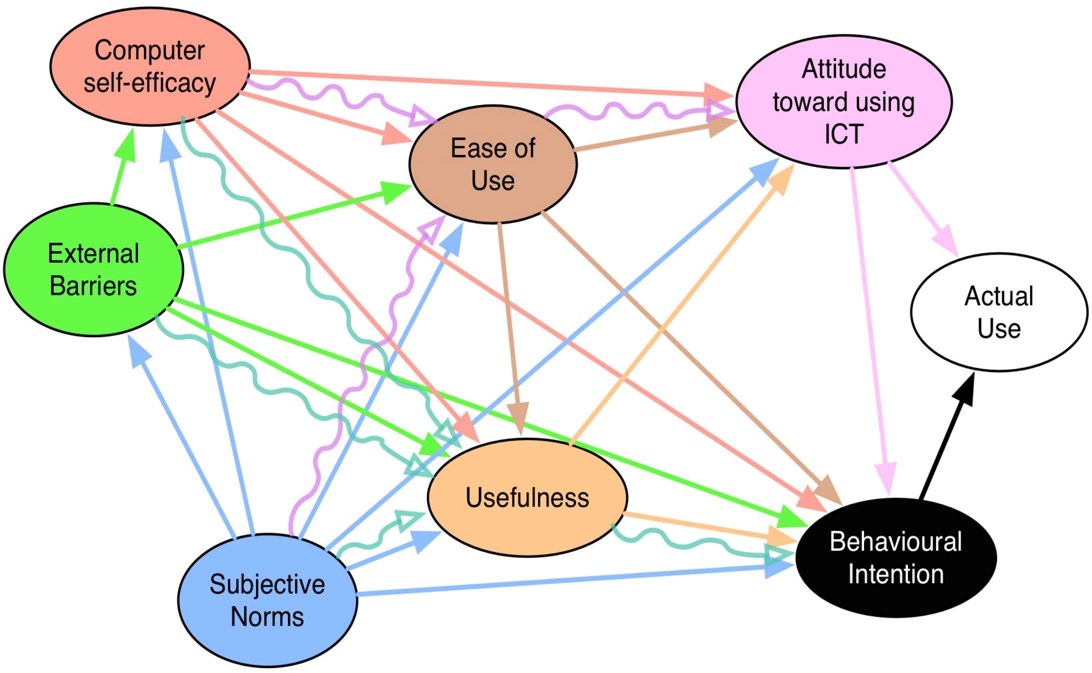


Figure 4.2: Proposed ICT Acceptance Model (ICTAM, modified from Davis et al., 1989, p. 985)


Sold arrows represent direct relationships


Wiggly arrows represent indirect relationships

The survey was administered to answer the first research question of the current study, "How does ICTAM model explain primary female science teachers' use of ICT in teaching?" Based on this question, the following research hypotheses were analysed in the current research:

4.2.1 The Research Hypotheses of the first research question

The research hypotheses study the relationship between each factor and another. From reviewing the literature it was found that using hypotheses is the best way of studying the relationship between different variables. These hypotheses were developed and established according to a deep discussion of the literature review in Chapter 3. More details of the research hypotheses are provided below:

4.2.1.1 Computer Self-Efficacy Hypotheses

Based on the study model relationships in Figure 4.2 computer self-efficacy is hypothesised to be a determinant of four constructs highlighted in red: ease of use; usefulness; attitude; and intention. Accordingly, four hypotheses were formulated based on Figure 4.2 to examine these relationships.

H1: Computer self-efficacy significantly and directly affects ease of use.
H2: Computer self-efficacy significantly and directly affects usefulness.
H3: Computer self-efficacy significantly and directly affects behavioural intention.
H4: Computer self-efficacy significantly and directly affects attitude toward using ICT in teaching.

4.2.1.2 Subjective norms hypotheses

Based on the study model relationships in Figure 4.2 subjective norms are hypothesised to be a determinant of six constructs: external barriers; computer self-efficacy; ease of use; usefulness; attitude; and intention highlighted in blue. Accordingly, six hypotheses were formulated based on Figure 4.2 to examine these relationships.

H5: Subjective norms significantly and directly affect perceived external barriers.
H6: Subjective norms significantly and directly affect computer self-efficacy.
H7: Subjective norms significantly and directly affect ease of use.
H8: Subjective norms significantly and directly affect usefulness.
H9: Subjective norms significantly and directly affect attitude.
H10: Subjective norms significantly and directly affect behavioural intention.

4.2.1.3 External barriers hypotheses

Based on the study model relationships in Figure 4.2 external barriers are hypothesised to be a determinant of four constructs: computer self-efficacy; ease of use; usefulness; and intention highlighted in green. Accordingly, four hypotheses were formulated based on Figure 4.2 to examine these relationships.

H11: External barriers significantly and directly affect computer self-efficacy.
H12: External barriers significantly and directly affect ease of use.
H13: External barriers significantly and directly affect usefulness.
H14: External barriers significantly and directly affect intention.

4.2.1.4 Ease of use hypotheses

Based on the study model relationships in Figure 4.2 ease of use is hypothesised to be a determinant of three constructs highlighted in brown: usefulness; attitude toward using ICT; and intention. Accordingly, three hypotheses were formulated based on Figure 4.2 to examine these relationships.

H15: Ease of use significantly and directly affects usefulness
H16: Ease of use significantly and directly affects attitude toward using ICT

H17: Ease of use significantly and directly affects behavioural intention

4.2.1.5 Usefulness hypotheses

Based on the study model relationships in Figure 4.2usefulness is hypothesised to be a determinant of two constructs: attitude toward using ICT; and intention highlighted in orange. Accordingly, two hypotheses were formulated based on Figure 4.2 to examine these relationships.

H18: Usefulness significantly and directly affects attitude toward using ICT.
H19: Usefulness significantly and directly affects behavioural intention.

4.2.1.6 Attitude toward using ICT hypotheses

Based on the study model relationships in Figure 4.2 attitude is hypothesised to be a determinant of two constructs: behavioural intention; and actual use of ICT highlighted in pink. Accordingly, two hypotheses were formulated based on Figure 4.2 to examine these relationships.

H20: Attitude toward using ICT significantly and directly affects behavioural intention.
H21: Attitude toward using ICT significantly and directly affects actual use of ICT in teaching.

4.2.1.7 Behavioural intention hypothesis

Based on the study model relationships in Figure 4.2 behavioural intention is hypothesised to be a determinant of one construct: actual use of ICT highlighted in black. Accordingly, one hypothesis was formulated based on Figure 4.2to examine this relationship.

H22: Behavioural intention significantly and directly affects actual use of ICT in teaching.

4.2.1.8 Mediation effect hypotheses

The second type of relationships in the proposed ICTAM is the mediation effect. Usefulness and ease of use were selected to play a role of mediation in the current study model.

4.2.1.9 Ease of use mediation effect hypotheses

Based on the study model mediation relationships in Figure 4.2 ease of use was selected to play a mediation role in the proposed ICTAM. Two hypotheses (purple wiggly arrows) were formulated based on Figure 4.2 to investigate the mediation effect in the proposed model.

H23: The effect of computer self-efficacy on attitude is partially mediated by ease of use.
H24: The effect of subjective norms on attitude is partially mediated by ease of use.

4.2.1.10 Usefulness mediation effect hypothesis

Based on the study model mediation relationships the ones with aqua dots in Figure 4.2 usefulness was selected to play a mediation role in the proposed ICTAM. Three hypotheses (aqua wiggly arrows) were formulated based on Figure 4.2 to investigate the mediation effect in the proposed model.

H25: The effect of computer self-efficacy on intention is partially mediated by usefulness.

H26: The effect of subjective norms on intention is partially mediated by usefulness.
H27: The effect of external barriers on intention is partially mediated by usefulness.
Table 4.1 summarises the constructs of the proposed model and the related hypotheses.

Table 4.1: Constructs of the proposed model and related hypotheses

		Hypotheses
Computer self-efficacy	H1	Computer self-efficacy significantly and directly affects ease of use
	H2	Computer self-efficacy significantly and directly affects usefulness
	H3	Computer self-efficacy significantly and directly affects intention
	H4	Computer self-efficacy significantly and directly affects attitude toward using ICT
Subjective norms	H5	Subjective norms significantly and directly affects ease of use
	H6	Subjective norms significantly and directly affect usefulness
	H7	Subjective norms significantly and directly affect computer self-efficacy
	H8	Subjective norms significantly and directly affect attitude toward using ICT
	H9	Subjective norms significantly and directly affect computer behavioural intention
	H10	Subjective norms significantly and directly affect external barriers
External barriers	H11	External barriers significantly and directly affect computer self-efficacy
	H12	External barriers significantly and directly affect ease of use
	H13	External barriers significantly and directly affect usefulness
	H14	External barriers significantly and directly affect behavioural intention
Ease of use	H15	Ease of use significantly and directly affects usefulness
	H16	Ease of use significantly and directly affects attitude toward using ICT
	H17	Ease of use significantly and directly affects behavioural intention
Usefulness	H18	Usefulness significantly and directly affects attitude toward using ICT
	H19	Usefulness significantly and directly affects behavioural intention
Attitude toward using ICT	H20	Attitude toward using ICT significantly and directly affects behavioural intention
	H21	Attitude toward using ICT significantly and directly affects actual use of ICT
Behavioural intention	H22	Behavioural intention significantly and directly affects actual use of ICT
Mediation effect of ease of use	H23	The effect of computer self-efficacy on attitude is mediated partially by ease of use
	H24	The effect of subjective norms on attitude is mediated partially by ease of use
Mediation effect of usefulness	H25	The effect of computer self-efficacy on intention is mediated partially by usefulness
	H26	The effect of subjective norms on intention is mediated partially by usefulness
	H27	The effect of external barriers on intention is mediated partially by usefulness

4.2.2 Survey Instrument

In the current study, the research instrument was a structured questionnaire. The relationships among the eight constructs, (perceived ease of use, perceived usefulness, attitudes toward using ICT, behavioural intention, self-efficacy to use ICT, perceived external barriers, subjective norms, and actual use of ICT) were examined. These constructs, which are not measured directly, were measured using scales based on the sums of corresponding measurement items to give the most obvious meaning to the constructs (Anderson & Gerbing, 1988) and to ensure greater validity and reliability of measures, because errors for each item tend to cancel each other out (DeVellis, 1991).

The survey instrument was developed by combining items that have been tested for reliability and validity by previous research studies with some adjustment to wording to reflect contextual differences. In both pilot and main study data, statistical analysis was used to confirm the validity and reliability of constructs. Table 4.2 shows the instruments and results from prior studies.

Table 4.2: Instruments and reliabilities from prior studies

Variable	Instrument	N	Reliability (α)
Behavioural intention	(Moon & Kim, 2001)	152	.87
Attitude	(Compeau & Higgins, 1995)	481	.87
	(Thompson et al., 1991)	212	.61
Perceived ease of use	(Davis, 1989)	120	.86
Perceived usefulness	(Davis, 1989)	120	.97
Self-efficacy to integrate technology	(Anderson & Maninger, 2007)	76	.92
Use of ICT	(Davis et al., 1989)	107	.79
Subjective norms	(Tarcan, Varol, and Toker, 2010)	510	.88

4.2.3 Operationalization of Variables

Perceived external barriers are defined in the current study as a teacher's beliefs about the external barriers that may hinder him or her from using ICT in teaching. The perceived external barriers instrument was created by combining items validated by previous authors. Items were measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire with their sources are shown below in table 4.3.

Table 4.3: External barriers items

The external barriers that will hinder me from teaching using ICT:	
Item	**Source**
Lack of resources (educational software)	Pelgrum, 2001
Lack of professional development opportunities on using ICT in teaching	Pelgrum, 2001
Lack of access to the Internet.	Lumpe & Chambers, 2001
There is not enough time in class to implement technology-based lessons.	Brush et al., 2008
Technology-integrated curriculum projects require too much preparation time.	Brush et al., 2008
Lack of technical support	Karagiorgi, 2005
Lack of support from school administrators, parents, or other teachers	Lumpe & Chambers, 2001

The external barriers that will hinder me from teaching using ICT:	
Item	**Source**
Lack of technology-integration plan	Fox & Henri, 2005
Lack of leadership	Fox & Henri, 2005
Pressure of High-stakes examinations	Fox & Henri, 2005
Lack of using ICT to measuring student learning through high-stakes examinations	Hennessy et al., 2005

Self-efficacy *to use ICT in teaching* is defined in the current study as a teacher's beliefs about his/her abilities to use ICT in teaching. Items were adopted and modified from Anderson and Maninger's (2007) instrument "self-efficacy for integrating technology" and were measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire are shown below in Table 4.4.

Table 4.4: Self-efficacy items

I feel confident that I could use ICT to:
Evaluate appropriately students' activities and tasks.
Select and use educational software for a defined task according to quality, appropriateness, effectiveness, and efficiency.
Create project-based learning activities that integrate ICT applications into the curriculum using a range of instructional strategies for individuals and small/whole groups.
Plan, select, and implement instruction that allows students to use ICT applications in problem-solving and decision-making situations
Teach students how to locate, retrieve, and retain content-related information from a range of texts technologies.
Perform administrative tasks such as taking attendance, maintaining grade books, and facilitating communication.
Create a lesson or unit that incorporates subject matter software as integral part.

Perceived usefulness is defined in the current study as a teacher's subjective opinion about whether using ICT will increase his or her teaching performance. Items were adopted and modified from the instrument for perceived usefulness provided by Davis (1989) and were measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire are shown below in table 4.5.

Table 4.5: Perceived usefulness items

Using ICT enables me to teach more quickly.
Using ICT improves my teaching performance.
Using ICT enhances my effectiveness in present teaching materials.
Using ICT makes lessons more motivating.
I find ICT useful for students to understand the lesson quicker.
Using ICT develops students' learning skills.

***Perceived ease** of use* is defined in the current study as the degree to which a science teacher expects the use of ICT in teaching to be free of effort. Items were adopted and modified from the instrument for perceived ease of use provided by Davis (1989) and were also measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire are shown below in table 4.6.

Table 4.6: Perceived ease of use items

Learning to use ICT in teaching is easy for me.
I find it easy to use ICT in teaching if I want to use.
My interaction with ICT in teaching is clear and understandable.
I find using ICT in teaching to be flexible to interact with.
It is easy for me to become skilful at using ICT in teaching.
I find using ICT in teaching easy to use.

Attitude toward using ICT is defined in the current study as the degree of a teacher's positive or negative feelings about using ICT in teaching. Items were modified from Thompson et al. (1991) and Compeau and Higgins (1995) and were also measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire are shown below in table 4.7.

Table 4.7: Attitude toward using ICT in teaching

Using ICT in teaching is interesting.
Using ICT in teaching is fun.
I like using ICT in teaching.
I look forward to those aspects of teaching that require me to use ICT.
Once I get using ICT in teaching, I find it hard to stop.

Behavioural intention is defined in the current study as the strength of a teacher's intention to use ICT in teaching in the future. Items were adopted and modified from the instrument provided by Moon and Kim (2001), and were also measured on a Likert-type scale ranging from 1 = unlikely to 5 = very likely. The items of the current questionnaire are shown below in Table 4.8.

Table 4.8: Behavioural intention items

I intend to use ICT in teaching when it becomes available in my school.
I intend to use ICT in teaching as often as possible.
I intend to use ICT in teaching on a regular basis in the future
I intend strongly to recommend others to use ICT in teaching.
I intend to use ICT in teaching in future.
I intend to use ICT in teaching often.

Use of ICT is defined in the current study as the frequency of ICT use in teaching science over a fixed unit of time. This dependent variable is operationalised in terms of the frequency of science teachers' ICT use in teaching. The various time frames of the frequency of ICT use that were used in the current study were: week 1 & 2, week 3 & 4, week 5 & 6, week 7 & 8, week 9 & 10, and week 11 & 12. In Kuwait usually there are 12 teaching weeks per semester. Moreover, each teacher generally teaches 10-15 lessons per week which means that he/she teaches 2-3 lessons per day. This study assumes that teachers will be able to assess the frequency of ICT use in their lesson during those time frames. The Items for frequency of use were adapted from the instrument published by Davis et al. (1989). *Use of ICT* was measured using questions regarding the frequency with which the science teacher uses ICT in teaching with categories: I did not use; 1 lesson; 2-5 lessons; 5-9 lessons; 10+ lessons. The items of the current questionnaire are shown below in Table 4.9.

Table 4.9: Use of ICT items

How many lessons did you use ICT in your teaching in the week 1&2?
How many lessons did you use ICT in your teaching in the weeks 3&4?
How many lessons did you use ICT in your teaching in the weeks 5&6?
How many lessons did you use ICT in your teaching in the weeks 7&8?
How many lessons did you use ICT in your teaching in the weeks 9&10?
How many lessons did you use ICT in your teaching in the weeks 11&12?

Subjective norms is defined in the current study as a teacher's perception of social pressure to use or not to use ICT in teaching. Items were adapted from Marcinkiewicz (1996) with *science Supervisor* added to the items used in Marcinkiewicz's questionnaire and were measured on a Likert-type scale ranging from 1 = strongly disagree to 5 = strongly agree. The items of the current questionnaire are shown below in Table 4.10.

Table 4.10: Subjective norms items

The following people would influence my use of ICT in teaching:
Principal
Head of department
Colleague
Supervisor
Parent
Student

4.2.4 Translation of research instruments

The participants of the current study are Arabic speakers. Hence, the questionnaire and interviews were translated from English to Arabic to ensure that the study was understandable in both languages. The translation process used in the current study is outlined below.

Forward and back translation technique was used in the current study. The questionnaires and interviews were translated into Arabic by two Kuwaiti educational experts that worked at the University of Kuwait who were aware of the concepts underlying the study of ICT and were bilingual. Hence, this translation provided a "reliable equivalence from a measurement perspective" (Beaton et al., 2000, p.3188). Then a native translator who was not aware of the concepts of the study translated the instrument from English to Arabic. The translations were then synthesised by those three experts and comparisons were made between the Arabic version and the original version of the questionnaires and interviews and then corrections were applied to the Arabic version of the instruments. Then one of the educational experts back translated the material into English. The original English version and the back translated version were compared for similarities and differences, and the corrected final version was prepared.

4.2.5 Population and Sample

There were about two hundred and fifty-three primary schools distributed over the six districts in Kuwait that most of them are taught by female teachers, while two to three schools in each district are taught by male teachers. There were approximately 2600 primary science teachers. The setting for the main study was limited to 500 female primary science teachers in all districts of Kuwait. Questionnaires were distributed by person, because the researcher wanted to make sure that all the questions will be answered by the participants. The researcher used a simple random approach to distribute the questionnaires. She chose every third school to be participating in answering the questions of the questionnaire. The entire primary science teachers of the randomly selected schools participated in the study as each school had nine to ten science teachers. From the total number of science teachers, 75 were from schools in district Aljahra (15%), 80 from Hawalli district (16%), 95 from Mubarak Al-kabeer district (19%), 100 from Al-Frwania (20%), 90 from Al-Aassma (18%), 60 from Al-Ahmady (12%).

Despite the numbers of teachers, students, computers, or networking resources differing from school to another, all primary schools follow the same rules of the department of primary schools that are affiliated to the ministry of education. Taking into account only primary teachers is important to control any irrelevant variables that could be confounded with other research variables especially because most of the primary teachers are females. The current study assumes that by including only local science teachers, the results would support generalization about local science teachers' perceptions towards the use of ICT. Consequently, any recommendations would be based on the Kuwaiti context. However, comparison of findings about science teachers' use of ICT between Kuwait and other countries, as reported in studies using similar instruments, would be justifiable.

4.2.6 Data collection

The questionnaire items were adapted from researchers who conducted their researches in English (see Appendix 1). However, the questionnaire for the current research was translated into Arabic (see Appendix 2), because participants were Arabic speakers (Harkness & Schoua-Glusberg, 1998). The questionnaire was translated into Arabic by two Kuwaiti educational experts that worked at the University of Kuwait, and a translator who was qualified to do the translation. This helped in gaining comparability of meanings, because they had good knowledge of the local culture (Birbili, 2000). Moreover, the two educational experts provided feedback on the content and comprehensibility of all the items of the questionnaire.

Pilot studies provide validation to questionnaire items and increase the success likelihood of the main study (Van Teijlingen & Hundley, 2001). A pilot study was conducted in the current study to reduce any inaccuracies and biases (Pallant, 2011). The pilot study was important for the current study as the questionnaire was translated from English to Arabic. The questionnaire was distributed to 25 female primary science teachers not included in the main study. The participants completed the survey in approximately 20 minutes, but there were some comments regarding some items. Based on the science teachers' comments some minor changes were made to the wording of questionnaire items.

The setting for the main study was limited to 500 female primary science teachers in all districts of Kuwait. Participants for the main study consisted of local female science teachers teaching in the six districts in Kuwait. The researcher distributed the questionnaires to the primary science teachers and explained the information and instructions for completing the questionnaire.

4.2.7 Statistical Data Analysis Techniques

This study built on a combination of different analysis systems incorporating Confirmatory Factor Analysis (CFA) to validate variables and enable Structural Equation Modelling (SEM) for evaluating the proposed ICTAM Model in order to examine its ability to explain science teachers' use of ICT. The following paragraphs detail steps in the process of Structural Equation Modelling (SEM) and the Confirmatory Factor Analysis (CFA).

4.2.7.1 Structural Equation Modelling (SEM)

SEM was used in the current study to assess the proposed ICTAM model and test the study model. SEM is a common statistical approach to testing hypotheses about relations among observed and latent variables (Hoyle, 1995). In particular, SEM combines aspects of factor analysis and multiple regression to examine the relationship between one or more observed variables and one or more dependent variables, both of which can be either factors or measured variables (Jodie, 2000; Kaplan, 2000; Hair, Black , Babin, & Anderson, 2010). SEM is employed to examine the relationships between constructs of different kinds of theoretical models (Karaca, Can, & Yildirim, 2013; Schumacker & Lomax, 2004). The use of SEM in the education sector has increased recently (Niederhauser & Perkmen, 2010; Teo, 2010).

The SEM consists of two main sub-models: the measurement model and the structural model (Joreskog, 1973; Byrne, 2010). The measurement model specifies the observed variables (indicators) for each latent variable and can be presented by using the confirmatory factor analysis (CFA) (Hair, Anderson, Tatham, & Black, 1998). The structural model assesses the reliability of latent variables and links the hypothesized variables to each other through systems of simultaneous equations (Schumacker & Lomax, 1996). As such, a structural model corresponds to a path diagram, and structural modelling is equated to path analysis.

CFA was used in the current study to describe the relationships between the indicators (measurement items) and latent variables (theoretical constructs). The principal advantage of CFA is that it allows for testing newly designed models. Also CFA has unique parameter estimates to identify a hypothesized model. Moreover, CFA provides goodness-of-fit indicators to assess the fitness of the hypothesized model (Marsh, 1985).

The measurement modelling procedure supports conclusions about the success of one or more of the observed variables as a measure of each of the theoretical latent variables during confirmatory factor analysis (Schumacker & Lomax, 1996). For example, in this study, the measurement model shows links between perceived usefulness of using ICT (a theoretical latent variable) and three or more measurement items (u1, u2, etc.) with the intention to determine the suitability of those observable variables as measures of the unobservable variable, perceived usefulness of using ICT in teaching.

The structural modelling procedure shows the strength of the causal structure among the latent variables in the research model (Byrne, 2009). For example, in this study the structural model shows a path from perceived ease of use (a latent variable) to perceived usefulness (another latent variable) to indicate that perceived usefulness is predicted to some extent by perceived ease of use. The previously assessed items in the measurement model were used to evaluate the structural model.

SEM has advantages that encouraged the researcher of the current study to use it to test the hypothesized model. SEM takes into account errors in observed variables and this helps in providing a more precise estimation of unobserved theoretical constructs; a feature which is unavailable in other multivariate analyses that assume there are no measurement errors in independent variables (Schumacker & Lomax, 1996). For example, the proposed model ICTAM that supported this study contained latent variables (such as external barriers, subjective norms, usefulness, ease of use, intention, actual use, and attitudes) that were measured by multiple observed variables, SEM was considered an appropriate statistical procedure with capability of amplified precision in evaluation since it handles errors in observed variables.

In addition, SEM enables testing fundamental interrelated causal relationships and incorporating the measurement data; unlike other multivariate analyses that test only a single step in a hierarchical model (Schumacker & Lomax, 1996). Accordingly, SEM is capable of estimating the size of the total effects of each independent variable on dependent variables in the path model by testing the direct and indirect effect (Kaplan, 2008).

The direct and indirect effect can be tested using a structural model. The structural model demonstrates the direct and indirect relationships between latent variables; and describes the amount of explained and unexplained variance (Hoyle, 1995). The direct effect records the strength of the direct path from a predictor variable to a particular dependent variable as indicated by the path coefficient, *B*. The indirect effect records the strength of indirect paths from a predictor variable to a dependent variable through mediator variable in the structural model. In this study for example, the direct effect of perceived usefulness (u) on behavioural intention (i) shows the strength of the path from (u) to (i) in the ICTAM model. Also, for example, the indirect effect of computer self-efficacy (cse) on attitude (a) indicates the strength of the effect of (cse) on (a) through the mediator variable, ease of use (eou). Thus the total effect of both direct and indirect variables on the dependent variables in the structural model can be determined.

4.2.7.2 Structural Equation Model Assessment steps

Measurement model and structural model were used in the current study to examine the proposed ICTAM model. Firstly, the researcher conducted an analysis of the measurement model that specifies the relationships between the latent variables and their corresponding observed variables of the proposed model. This step (testing the measurement model) was important to verify the reliability and validity of the observed variables that were used as measures of the respective latent variables. The importance of this step was to ensure that the measurement model suits the sample data in order to proceed with the full model testing (Hoyle, 1995). SEM was used to test the hypothesis for observed and latent variable. CFA was used to test and describe the relationships between the indicators and the latent variables

The next step, after confirming the reliability and validity of the measurement model, was to conduct the estimation of the structural model that shows causal relationships between the latent variables. These two types of models, measurement and structural models were necessary to avoid misinterpretation between measurement and structural models (Anderson & Gerbing, 1988; Segars & Grover, 1993). The misinterpretation according to low reliability or multiple factor loadings can lead to misfit of the model. Therefore, it was important in the study to make sure that the results of testing items in the measurement model are reliable and valid so that the results of the following structural modelling can be interpreted confidently.

The following two sections describe first evaluation of the measurement model and then the structural model.

4.2.7.3 Evaluation of Measurement Model

Firstly data were entered into SPSS 21 software. The data then were examined for normality. Then Analysis of Moment Structures (AMOS 21 software) was employed for CFA that evaluated the reliability and validity of the factors and the general measurement model. Detailed discussions on both techniques are in the following paragraphs.

Descriptive statistics

SPSS 21 was employed for statistical analysis. Descriptive analysis was conducted as the main step of statistical analysis (Kline, 2005). The purpose of the descriptive statistics is to identify violation in variables (Pallant, 2011). Two main statistical indicators were used to describe the data: mean and standard deviation. Then the measurement model was employed by relating each observed variable (i.e. the measurement item) to its corresponding latent variable (i.e. the theoretical factor) using CFA.

Confirmatory Factor Analysis (CFA)

AMOS 21.0 software was used for evaluating the specified measurement model (Byrne, 2009). Confirmation of the fit of the measurement model using CFA was obtained from assessing goodness-of-fit indicators. The indicators of model fit enable the researcher to identify if the model fits the sample of data (Hair, Black, Babin, Anderson, & Tatham, 2006). The goodness-of-fit indicators used in the current study were: Ratio of Chi-square/Degrees of Freedom (CMIN/DF), Adjusted Goodness-of-Fit Index (AGFI), Non-Normed Fit Index (NNFI), Root Mean-square Residual (RMR), and Root Mean-square Error of Approximation (RMSEA). These fit indices were grouped into three clusters: absolute fit indices, incremental fit indices, and parsimony fit indices.

Chi-square χ^2 is an important indicator to assess the model fitness. However, "a very large (or small) sample size will often yield a significant chi-square value that can result in the rejection of a correct model" (Dai, 2010, p.54). Therefore, the Ratio of Chi-square/Degree of Freedom was used to assess the model. The acceptable level of CMIN/DF in the current study was 1 to 2 (Holmes-Smith, 2011).

Root Mean Error of Approximation (RMSEA) is one of the most informative indices for assessing model fit (Byrne, 2010; Steiger, 1990). The cut-off value used in the current study was 0.08 (Arbuckle, 1995; Arbuckle, 2005; McDonald & Ho, 2002).

Root Mean-square Residual (RMR) is used to assess the model fit based on the residual (Holmes-Smith, 2011). Byrne (2010) defined RMR as a measure of the discrepancy between the variances and covariances matrix for the hypothesised model and the variances and covariances of the sample. The cut-off value used in the current study was 0.05 or less (the smaller value the better) (Arbuckle, 1995; Arbuckle, 2005; McDonald & Ho, 2002).

The adjusted Goodness-of-Fit Index (AGFI) takes into account the degree of freedom in the specified model (Holmes-Smith, 2011). AGFI is very sensitive to model complexity (Hooper, Coughlan, & Mullen, 2008; Jais, 2007). This led to differences between researchers' decisions regarding the cut-off value for AGFI. Many of the researchers have recommended 0.90 or more as the cut-off value (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999; Pynoo, Devolder, Tondeur, Braak, Duyck, & Duycki, 2011). However, Jais (2007) recommended 0.80 or more as the cut-off value for complicated models. The model of the current study was considered complex as it comprised 8 latent variables and 53 observed. Therefore, the cut-off value used in the current study was 0.80 or more (Abdulla, 2007; MacCallum & Hong, 1997; Mazman & Usluel, 2010).

Non-Normed Fit Index (NNFI) is an indicator of incremental fit (Bentler & Bonett, 1980). This indicator has solved the problem of underestimating the fit of the model in good-fitting with small samples that has been facing researchers when using Normed Fit Index (NFI) (Bentler & Bonett, 1980). This study used 0.95 or more as the cut-off value (Bentler & Bonett, 1980; Hu & Bentler, 1999).

The model fit indices and the cut-off values that were adopted in the current study are summarized in Table 4.11 and the results of comparing the default with the null model are provided in Chapter 5 Section 5.4.

Table 4.11: Model fit indices used in the current study

Model Fit Indices	Acceptable level	References
Normed Chi-square (CMIN/DF)	1-2	Holmes-Smith, 2011
Root Mean Error of Approximation (RMSEA)	≤0.08	Arbuckle(1995), Arbuckle (2005), McDonald & Ho (2002)
Root Mean-square Residual (RMR)	≤0.05	Arbuckle(1995),Arbuckle(2005) McDonald & Ho(2002)
adjusted Goodness-of-Fit Index (AGFI)	≥0.80	(MacCallum & Hong(1997), Jais(2007) Abdulla (2007),Mazman&Usluel(2010).
Non-Normed Fit Index (NNFI)	≥ 0.95	Bentler & Bonett(1980), Hu & Bentler (1999)

4.2.7.4 Mediating effect

Mediating effect is defined as the "effect of a third variable/construct intervening between two other related constructs" (Hair et al., 2010). A mediator function is to explain the reason behind the relationship between a predictor and dependent variable by clarifying why/how this relationship exists (Holmbeck, 1997).

Perceived usefulness and perceived ease of use were key predictors in the proposed model. These constructs were hypothesised to be mediation factors in the model. Therefore, the method to analyse the mediation effect of perceived usefulness and ease of use was identified in this section.

Baron and Kenny (1986) suggested a partial mediation approach to test the mediating effect. This approach relies on estimating each of the paths in the model to see whether a variable functions as a mediator as a result of meeting the conditions. There are conditions to examine the mediation according to this approach (Baron & Kenny, 1986). The first condition is that before conducting the test of mediating effect it is necessary to have a significant direct effect between the predictor and dependent variable. The second condition is that the direct effect between predictor and mediator variable is significant. The third condition is that the direct effect between mediator and dependent variable is significant. Baron and Kenny (1986) indicated that if the direct effect between predictor and dependent variable reduced to a point where it is not statistically significant the type of mediation is full, and if the direct effect between predictor and dependent variable reduced but remained significant the type of mediation is partial.

Hair et al. (2010) added another step for the approach that was suggested by Baron and Kenny (1986) to test the mediation effect. Hairs et al. (2010) suggested two steps in regard to mediation. The first step, which was based on the work of Baron and Kenny (1986), required examining the three conditions of mediation. First condition is that the independent variable significantly affects the dependent variable. Second condition is that the independent variable significantly affects the mediator variable. Third condition is that the mediator significantly affects the dependent variable.

The second step that was suggested by Hair et al. (2010) is to first estimate an initial model that studies only the direct effect of the independent variable on the dependent variable. Then, the mediator variable is added by estimating a second model that studies the effect of predictor variable on the mediator variable, and the effect of the mediator variable on the dependent variable. According to Hair et al. (2010) if the relationship between the independent variable and the dependent variable is significant and unchanged once the mediator variable is included, then there is no mediation; if the relationship between the independent variable and the dependent variable is reduced but remains significant once the mediator variable is included, then there is a partial mediation; if the relationship between the independent variable and the dependent variable is reduced to a point where it is not significant once the mediator variable is included, then there is a full mediation.

These two steps were used to test the effect of computer self-efficacy (CSE) and subjective norms (SN) on attitude (A) mediated by (EOU). Also, these steps were used to test the effect of subjective norms (SN), external barriers (EB), and computer self-efficacy on intention (I) mediated by usefulness (U).

To summarize, the mediating effects to be examined in this study are shown in Table 4.12.

Table 4.12: Mediating effects

Perceived usefulness	Ease of use
• **The effect of external barriers on intention is mediated partially by usefulness** • **The effect of subjective norms on intention is mediated partially by usefulness** • **The effect of computer self-efficacy on intention is mediated partially by usefulness**	• The effect of subjective norms on attitude is mediated partially by ease of use • The effect of computer self-efficacy on attitude is mediated partially by ease of use

4.2.8 Reliability

This study used a questionnaire as an instrument to investigate science teachers' perceptions towards using ICT and to assess the proposed ICTAM ability to predict science teachers' use of ICT in teaching. The findings of the questionnaires can be used as evidence of the primary science teachers' willingness to use ICT.

It is necessary for the questionnaires to be reliable. Reliability means that the measuring results of the questionnaire must be consistent (Neuman, 2006). The indicators that were used in the current study to measure reliability were: Squared Multiple Correlation (SMC), Construct Reliability (composite reliability), and Cronbach's alpha.

The squared multiple correlation measures the reliability of each indicator variable (Bagozz & Yi, 2012) and the amount of variance in latent variables accounted for by the predictors (Schumacker & Lomax, 2004). The recommended value used in the current study was $R^2 > 0.3$ (Bagozz & Yi, 2012). Construct reliability measures the reliability of all the indicators of each construct. The recommended value used in the current study was 0.70 (Bagozz & Yi, 2012). The recommended value for Cronbach's alpha used in the current study was 0.70 (Hair et al., 2006).

4.2.9 Validity

Validity means that it measures what it claims to measure (Neuman, 2006). Testing the validity in the structural equation modelling determines the validity of the indicators used to measure the constructs. Two types were used in the current study: Convergent Validity and Discriminant Validity. Convergent Validity assesses relationships between the indicators and the constructs (Fornell, Tellis, & Zinkhan, 1982; Schumacker & Lomax, 2004). This kind of validity is assessed by the loading factor. The loading factor for each item in the construct should equal or exceed 0.05 to achieve convergent validity (Aggelidis & Chatzoglou, 2012; Holms-Smith, 2011). The Discriminant Validity is assessed by comparing the average variance extracted (AVE) for a given construct with the square correlations between that construct and all other constructs (Hair et al., 2006). The value of AVE should be greater than the value of square correlation between the given construct and others in the model to achieve discriminant validity.

4.3 Qualitative data

For the qualitative data semi-structured interviews were used in the current study to provide rich data from teachers who have an in-depth knowledge about the factors affecting the ICT integration. Interviews were conducted with 21 female primary science teachers. According to the teachers' answers in the questionnaires, it was possible to divide the teachers into three types. Three types of teachers were selected on the basis of their frequency of use of ICT in teaching as it was believed that those selected teachers would provide information-rich cases (Rossman & Rallis, 2003; Wiersma, 2000). Type one teachers included teachers who always used ICT in teaching in the last six months. Type two teachers were teachers with average use of ICT in teaching in the last six months. Type three teachers included teachers who did not use ICT in teaching in the last six months. A semi-structured interview guide, (see Appendix 3), was prepared for one on one interviews with science teachers (Cannell & Kahn, 1968).

The advantages of using the semi-structured interview are: 1) questions and content are organized in advanced for the triangulation of evidence (Denzin, 1978; Smith & Kleine, 1986); 2) the researcher has flexibility to add further questions based on the answers that emerge during the interview (May, 2001; Chambliss & Schutt, 2012); 3) they provide a greater depth compared to other methods such as questionnaires (Cohen & Manion, 1994; Gay & Airasian, 2009).

4.3.1 Interview instrument

The development of the Interview instrument was based on the research questions: 2) what are the factors that prevent or encourage science teachers to use ICT in teaching? 3) To what extent do science teachers use ICT in teaching? The interview questions (see Appendix 3) emerged from, and were related to, the survey questionnaire (see Appendix 1). The interview questions were translated into Arabic (see Appendix 4). The interviews began with general questions about the age of the interviewed teachers; experience; possession of laptops or Internet; and availability of technical support within school. The themes that were addressed during the interviews were:

1) Science teachers' views on the barriers that may prevent them from using ICT in teaching.
2) Science teachers' views on the incentives to use ICT in teaching.
3) Identifying other people who affect teachers' use of ICT in the classroom.
4) Explaining the actual use of ICT in teaching.

4.3.2 Data collection

Semi-structured interviews were conducted with 21 female primary science teachers who were selected from among the 500 teachers who had completed the questionnaire. The teachers were contacted by telephone to gain their acceptance (Buchanan, Boddy, & McCalman, 1988). Importantly, their selection was to gain in-depth information about the factors that may hinder or encourage science teachers to use of ICT in teaching, and the extent to which science teachers used ICT in teaching. These interviews took place within the schools of the participants. Typically, interviews lasted 30-60 minutes. Following the completion of the face-to-face interviews with the teachers, the notes of interview were transcribed and translated into English for analysis.

4.3.3 Analysis of Interviews

Interviews with 21 science teachers were transcribed and translated into English. To protect teachers' privacy, the researcher used symbolic codes to identify each teacher. Each interview was coded with the initial letters of each of the two words, science teacher ST, along with the number representing the interview (e.g. ST1, ST2, ST3, etc). The translated interviews were imported into a qualitative software program, NVivo 10.

The use of computer software to analyse the qualitative data is recommended as it facilitates coding, comparing, linking, and storing data (Patton, 2002). Moreover, it helps the research to make sense of unstructured data, and save time on analysis compared to manual analysis (Sarantakos, 2005). The analytical software NVivo 10 is one of the most popular programs that are used by researchers to analyse qualitative data due to its efficacy in managing the data (Lichtman, 2006). Therefore, the current study employed NVivo to conduct the analysis of the interviews.

The analysis of interviews was conducted using the program software, NVivo 10, following Lichtman's (2006) model of analysis (Figure 4.3). The first step of analysing the qualitative data was by reading the transcripts and creating initial codes. The next step was rereading the initial coding to delete the unnecessary codes. The following step was to develop an initial list of categories. After that, the initial list of categories was reread for modification. Then, the researcher checked the categories and sub-categories for any modification. The final step was to move from categories into themes.

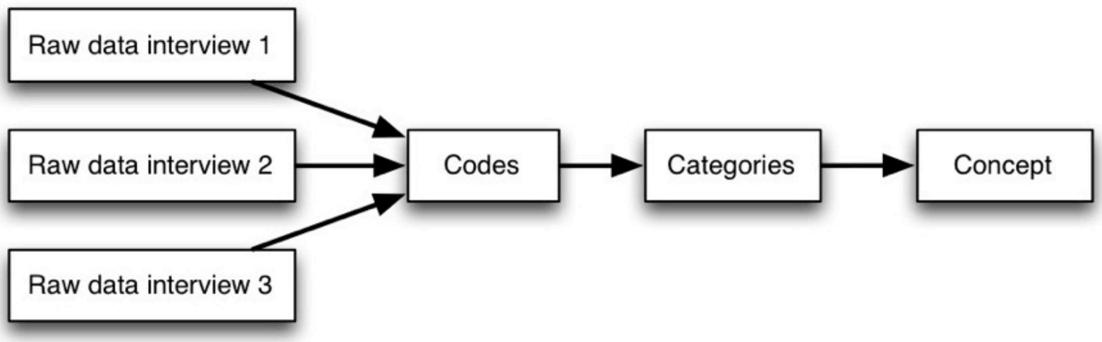


Figure 4.3: Qualitative data analysis: Codes, categories, and concepts (Lichtman, 2006, p. 168)

Coding is the central feature of thematic analysis (Lichtman, 2006) as it depends on reading the material, organizing it into segments of text (Sarantakos, 2005), and marking these segments of data with category names (Johnson & Christensen, 2004).

After the accomplishment of the coding process, main themes emerged from the clustering of categories. These main themes helped in providing a well-structured analytical framework that systemized the analysis shown in Section 6.2.

4.4 Ethical considerations

Ethical considerations were taken into account in the current study. Approval for the research was obtained from the University of Southern Queensland Human Research Ethics Committee prior to data collection as the study involved human subjects.

The participants of the current study were Arabic speakers, which led the research to translate the study instruments into Arabic. The translation was accomplished by an independent translator and two educational experts to assure that the instruments were easily understandable.

During the period of the survey data collection, the researcher attached a letter with a consent form to ensure that all participants were informed of the nature of study and the confidentiality of responses before participating. Interview data collected were treated confidentially using identification numbers to protect teachers' privacy.

4.5 Summary

The current study was designed as a mixed method study. It was designed to identify the factors that affect the use of ICT in teaching by science teachers. Therefore, the proposed ICTAM was developed to assess teachers' acceptance of ICT. The study was conducted in two stages: a questionnaire survey of the science teachers to examine the ability of the proposed model to explain primary science teachers' use of ICT in teaching; and a semi-structured interview to provide rich data from teachers who have an in-depth knowledge about the factors affecting the ICT integration. The study aimed to assess the ability of the proposed model to explain primary science teachers' perceptions regarding the use of ICT in the classroom. It also sought to identify the factors that affect science teachers' use of ICT and the relationship between these variables. Moreover, it sought to determine the extent to which ICT was used in the classroom.

The benefits of the proposed model relied on identifying the factors that affect teachers' use of ICT, identifying the causal relationships among these variables, and identifying how ICT was used in the classroom. The benefits of the in-depth investigations relied on supporting the proposed model in identifying the factors that affect teachers' use of ICT in the classroom, and how ICT is used by teachers as a teaching method. It was anticipated that identifying the barriers that hinder teachers from using ICT in teaching would inform future developments to enable teachers to successfully implement ICT in teaching.

The following chapters (Chapter 5, 6, and 7) present details of the data analysis, with findings from the questionnaire and interviews.

Chapter 5: Analysis of Science Teachers' Survey Data

Science teachers are expected to integrate ICT in their teaching. However, they have the choice about whether or how to use it in their teaching. Thus, evaluating the acceptance of using ICT in teaching based on the perspective of science teachers provides an important view about the factors affecting their use of ICT and the relationships between these factors. As described in Chapter 4, eight constructs were used in the model for this study to evaluate the acceptance of ICT: computer self-efficacy; subjective norms; perceived external barriers; perceived ease of use; perceived usefulness; attitude to ICT; intention to use ICT; and actual use of ICT.

This chapter describes and tests the survey data collected from the sample of science teachers. The chapter includes three main sections. The first section describes the data collected from teachers and examines the normality of the distributions. The second section tests the study model and hypotheses using structural equation modelling. Finally, a description of testing the structural model and hypotheses forms the third section of this chapter.

5.1 Participants' Background Information

As described in Chapter 4 a total of 500 science teachers from primary schools in the six districts in Kuwait responded to the survey used in the current study. From the total number of science teachers, 75 were from schools in district Aljahra (15%), 80 from Hawalli district (16%), 95 from Mubarak Al-kabeer district (19%), 100 from Al-Frwania (20%), 90 from Al-Aassma (18%), 60 from Al-Ahmady (12%). All the respondents from all districts were female primary science teachers.

Table 5.1 represents the age of teachers in the study. The table indicates that 70% of teachers are 35 years old or younger, while fewer than 10% are older than 40 years old. Figure 5.1 shows the frequency of teachers' ages. The mean of the teachers' ages is 2.8; this indicates that most of the teachers are 31-35 years old.

Table 5.1: Teacher ages

Age	Frequency	Percent	Valid percent	Cumulative percent
20-25	80	16.0	16.0	16.0
26-30	141	28.2	28.2	44.2
31-35	133	26.6	26.6	70.8
36-40	103	20.6	20.6	91.4
41-45	31	6.2	6.2	97.6
≥46	12	2.4	2.4	100
Total	500	100.0	100.0	

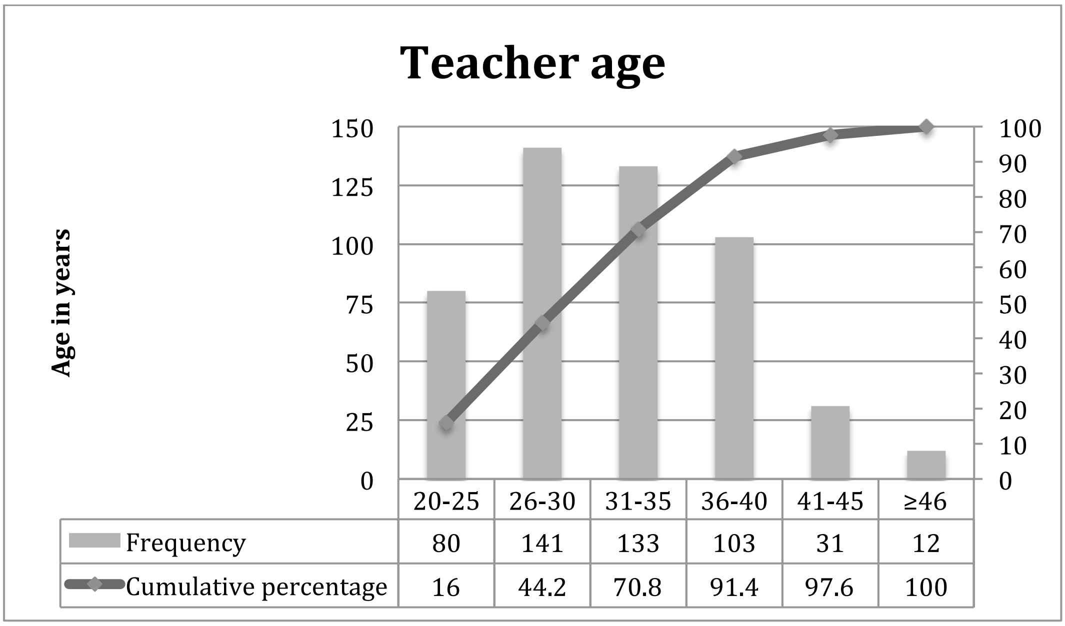


Figure 5.1: Chart of teacher age frequency

Table 5.2 represents the years of experience of the science teachers. The table indicates that many of the science teachers seem to have long years of experience. More than 60% have at least 5 years of experience, while 35% have more than 10 years of experience. Figure 5.2 shows the chart of teachers' years of experience frequency. The mean of teachers' years of experience is 3.06; this indicates that most of the teachers have 6-10 years of experience.

Table 5.2: Years of teaching experience

Frequency	Percent	Valid Percent	Cumulative Percent	
less than one year	28	5.6	5.6	5.6
1-5 years	156	31.2	31.2	36.8
6-10 years	144	28.8	28.8	65.6
11-15 years	115	23.0	23.0	88.6
16-20 years	42	8.4	8.4	97.0
≥21 years	15	3.0	3.0	100.0
Total	500	100.0	100.0	

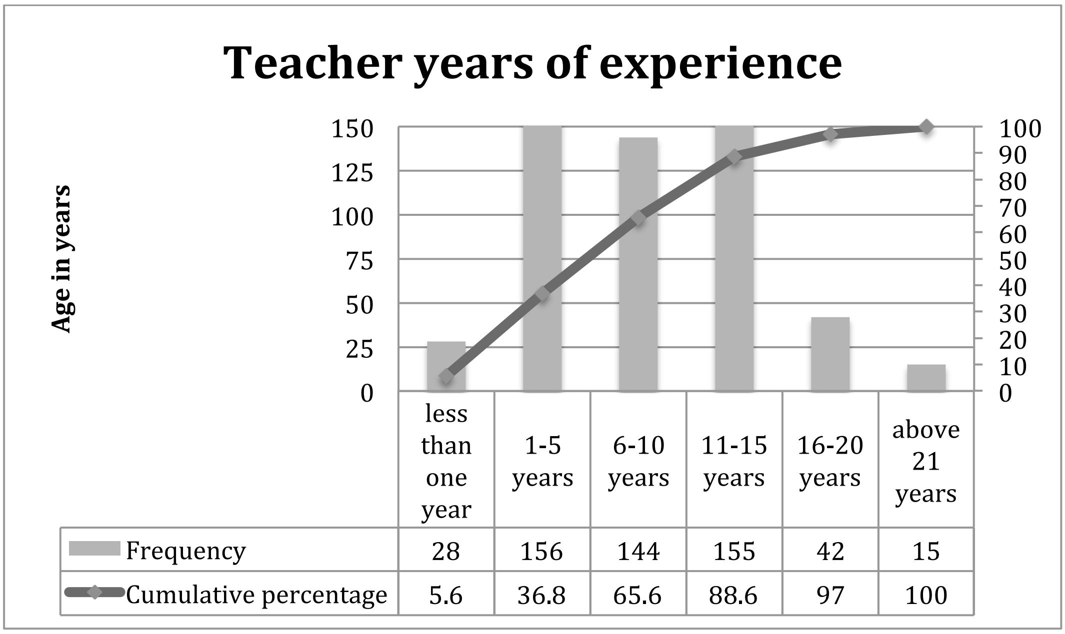


Figure 5.2: Chart of teachers' years of experience frequency

5.2 Descriptive statistics

Descriptive statistics are an essential part of data analysis (Zikmund et al., 2009) and can be used to present the respondents' perceptions towards each item and the variables of the survey. Furthermore, possible inconsistencies in variables can be identified using descriptive statistics indicators (Pallant, 2011).

Using SPSS 21 software two statistics, mean and standard deviation, were used to describe the responses of science teachers on the variables represented in the survey data. There were 500 science teachers in the sample. A 5-point Likert scale was used to measure the perceptions of teachers toward constructs of the proposed model: 1 = 'Strongly Disagree', 2 = 'Disagree', 3 = 'Neutral', 4 = 'Agree', and 5 = 'Strongly Agree'. Explanations of missing data and outliers are also reported in this section of the current study. Tests of the normality of the data distribution were employed using two statistics indicators: skewness and kurtosis.

5.2.1 Computer self-efficacy

In regard to computer self-efficacy, seven items were used to measure the self-efficacy of using ICT in teaching. The descriptive indicators are shown in Table 5.3. The means of computer self-efficacy items ranged between 3.40 for cse1 and 3.91 for cse6. These means indicated that the items were accepted by respondents with some level of agreement in most cases.

The descriptive statistics indicators showed the positive perceptions of science teachers towards their self-efficacy to use ICT in teaching. These results indicated that the surveyed teachers paid attention in responding to the questionnaire and they had self-efficacy in using computers in teaching.

Table 5.3: Descriptive indicators of computer self-efficacy (n=500)

Items	Mean	Std. Deviation
Evaluate appropriately students' activities and tasks	3.40	1.313
Select and use educational software for a defined task according to quality, appropriateness, effectiveness, and efficiency	3.59	1.245
Create project-based learning activities using a range of instructional strategies for individuals and small/whole groups.	3.46	1.211
Plan, select, and implement instruction that allows students to use ICT in problem-solving and decision-making situations.	3.52	1.200
Teach students how to locate, retrieve, and retain content-related information from a range of texts and technologies.	3.63	1.225
Perform administrative tasks such as taking attendance, maintaining grade books, and facilitating communication.	3.91	1.284
Create a lesson or unit that incorporates subject matter software as an integral part.	3.80	1.230

5.2.2 Subjective norms

Six items were employed to measure the subjective norms construct. The means of the subjective norms items ranged between 3.07 for sn5 and 3.74 for sn2. These means indicated that science teachers accepted the items used to gauge the subjective norms construct and agreed on the importance of opinions of significant people about using ICT in teaching. The indicators of descriptive statistics are shown in Table 5.4.

Table 5.4: Descriptive indicators of subjective norms

Items	Mean	Std. Deviation
Principal	3.53	1.409
Head of department	3.74	1.307
Colleague	3.40	1.334
Supervisor	3.64	1.313
Parent	3.07	1.429
Student	3.63	1.386

5.2.3 Perceived external barriers

The perceived external barriers construct was measured using eleven items. The measures of the items were reverse scored because the Perceived External Barriers construct measures the barriers so the measures became: 5 = 'Strongly Disagree', 4= 'Disagree', 3 = 'Neutral', 2 = 'Agree' and 1 = 'Strongly Agree'. The means for the perceived external barriers items ranged between 1.61 for EB3 and 1.82 for EB9. These means indicated that science teachers tended to agree that there were external barriers that affected their use of ICT. The descriptive statistics are shown in Table 5.5.

Table 5.5: Descriptive indicators of perceived external barriers

Items	Mean	Std. Deviation
Lack of resources (educational software).	1.70	.770
Lack of professional development opportunities on using ICT in teaching.	1.78	.748
Lack of access to the Internet.	1.61	.758
There is not enough time in class to implement technology-based lessons.	1.75	.771
Technology-integrated curriculum projects require too much preparation time.	1.78	.811
Lack of technical support.	1.71	.767
Lack of support from school administrators, parents, or other teachers.	1.79	.785
Lack of technology-integration plan.	1.82	.775
Lack of leadership.	1.82	.791
Pressure of High-stakes examinations.	1.74	.790
Lack of using ICT to measure student learning through high-stakes examinations.	1.81	.787

5.2.4 Perceived ease of use

Six items were employed to measure the perceived ease of use construct. The descriptive statistics indicators are shown in Table 5.6. The means of the Perceived ease of use items ranged between 3.62 for eou1 and 3.77 for eou5. These means indicated that science teachers had positive opinions toward the ease of the use of ICT.

Table 5.6: Descriptive indicators of perceived ease of use

Items	Mean	Std. Deviation
Learning to use ICT in teaching is easy for me.	3.62	1.235
I find it easy to use ICT in teaching if I want to use it.	3.72	1.198
My interaction with ICT in teaching is clear and understandable.	3.69	1.120
I find using ICT in teaching enables more flexible interaction.	3.75	1.146
It is easy for me to become skilful at using ICT in teaching	3.77	1.204
I find ICT easy to use in my teaching.	3.73	1.173

5.2.5 Perceived usefulness

Perceived usefulness was measured using six items. The descriptive statistics indicators are shown in Table 5.7. The means of the perceived usefulness items ranged between 3.84 for u1 and 4.0 for u4. These means indicated that science teachers had positive opinions toward the usefulness of ICT in teaching.

Table 5.7: Descriptive indicators of perceived usefulness

Items	Mean	Std. Deviation
Enables me to teach more quickly.	3.84	1.198
Improves my teaching performance.	3.87	1.167
Enhances my effectiveness in present teaching materials.	3.92	1.137
Makes lessons more motivating.	4.00	1.127
Helps students understand the lessons better.	3.93	1.166
Develops students' learning skills.	3.94	1.177

5.2.6 Attitude toward using ICT in teaching

Five items were employed to measure attitude toward using ICT in teaching. The descriptive statistics indicators are shown in Table 5.8. The means of the attitude toward using ICT in teaching items ranged between 3.68 for a5 and 3.98 for a1. The means indicated that science teachers had positive attitudes toward the use of ICT in teaching.

Table 5.8: Descriptive indicators of attitude toward using ICT in teaching

Items	Mean	Std. Deviation
Using ICT in teaching is interesting.	3.98	1.197
Using ICT in teaching is fun.	3.94	1.162
I like using ICT in teaching.	3.93	1.138
I look forward to those aspects of teaching that require me to use ICT	3.84	1.138
Once I get using ICT in teaching, I find hard to stop.	3.68	1.160

5.2.7 Behavioural Intention

Intention was measured using six items. The indicators of descriptive statistics are shown in Table 5.9. The means of Intention ranged between 3.82 for i6 and 4.05 for i1. The means indicated that science teachers had positive intention toward the use of ICT in teaching.

Table 5.9: Descriptive indicators of behavioural intention

Items	Mean	Std. Deviation
I intend to use ICT in teaching when it becomes available in my school.	4.05	1.129
I intend to use ICT in teaching as often as possible.	3.96	1.072
I intend to use ICT in teaching on a regular basis in the future.	3.94	1.076
I intend to recommend strongly to others to use ICT in teaching.	3.93	1.104
I intend to use ICT in teaching in future.	3.98	1.111
I intend to use ICT in teaching often.	3.82	1.137

5.2.8 Actual use

Actual use was measured using six items. The indicators of descriptive statistics are shown in Table 5.10. The means of actual use items ranged between 3.05 for au5 and

3.47 for au6. These means highlighted that the science teachers used ICT in their teaching regularly.

Table 5.10: Descriptive indicators of actual use of ICT

Items	Mean	Std. Deviation
How many lessons did you use ICT in your teaching in the week 1&2?	3.10	1.158
How many lessons did you use ICT in your teaching in the week 3&4?	3.31	1.076
How many lessons did you use ICT in your teaching in the week 5&6?	3.17	1.071
How many lessons did you use ICT in your teaching in the week 7&8?	3.39	1.059
How many lessons did you use ICT in your teaching in the week 9&10?	3.05	1.159
How many lessons did you use ICT in your teaching in the week 11&12?	3.47	1.084

5.3 Treatment of missing data, outliers, and normality

In the current study all questionnaire items for which the data were to be entered into SPSS were fully answered. The researcher distributed the questionnaires in person and ensured that all the answers were understood and filled in by all respondents. Thus, there were no missing data.

The data entered into SPSS were checked for outliers by inspecting the frequency distributions. Pallant (2011, p. 64) defines outliers as ‘cases with values well above or well below the majority of other cases’. The values of standard deviations were confirmed to lie within no more than 2 which is the range of scale used in the current study. Thus, there were not any outliers in the current study.

Two statistical tests were used to examine the normality: skewness and kurtosis. Table 5.11 depicts the skewness and kurtosis of each item of the science teachers’ questionnaire. According to the criteria +3 -3 (Peat & Barton, 2005) and as shown Table 5.11, the items adopted in this study are distributed normally.

Table 5.11: Normality test: skewness and kurtosis of each item

	N	Skewness			Kurtosis
		Statistic	Std. Error	Statistic	Std. Error
cse1	500	-.305	.109	-.996	.218
cse2	500	-.527	.109	-.724	.218
cse3	500	-.404	.109	-.685	.218
cse4	500	-.421	.109	-.759	.218
cse5	500	-.553	.109	-.662	.218
cse6	500	-.959	.109	-.218	.218
cse7	500	-.765	.109	-.385	.218
sn1	500	-.508	.109	-1.059	.218
sn2	500	-.792	.109	-.484	.218
sn3	500	-.353	.109	-1.031	.218
sn4	500	-.634	.109	-.756	.218
sn5	500	-.017	.109	-1.314	.218
sn6	500	-.600	.109	-.919	.218
eb1	500	.581	.109	-1.090	.218

	N	Skewness		Kurtosis	
		Statistic	Std. Error	Statistic	Std. Error
eb2	500	.390	.109	-1.126	.218
eb3	500	.780	.109	-.844	.218
eb4	500	.454	.109	-1.187	.218
eb5	500	.422	.109	-1.355	.218
eb6	500	.556	.109	-1.101	.218
eb7	500	.380	.109	-1.284	.218
eb8	500	.323	.109	-1.270	.218
eb9	500	.324	.109	-1.335	.218
eb10	500	.505	.109	-1.224	.218
eb11	500	.349	.109	-1.306	.218
eou1	500	-.532	.109	-.726	.218
eou2	500	-.676	.109	-.495	.218
eou3	500	-.570	.109	-.350	.218
eou4	500	-.686	.109	-.315	.218
eou5	500	-.755	.109	-.361	.218
eou6	500	-.620	.109	-.560	.218
u1	500	-.839	.109	-.221	.218
u2	500	-.851	.109	-.157	.218
u3	500	-.921	.109	.057	.218
u4	500	-.995	.109	.161	.218
u5	500	-.914	.109	-.039	.218
u6	500	-.894	.109	-.120	.218
a1	500	-1.050	.109	.138	.218
a2	500	-.950	.109	.014	.218
a3	500	-.895	.109	.017	.218
a4	500	-.781	.109	-.138	.218
a5	500	-.544	.109	-.518	.218
i1	500	-1.056	.109	.204	.218
i2	500	-.879	.109	.079	.218
i3	500	-.893	.109	.157	.218
i4	500	-.817	.109	-.080	.218
i5	500	-.921	.109	.021	.218
i6	500	-.730	.109	-.264	.218
au1	500	-.756	.109	-.415	.218
au2	500	.357	.109	-1.126	.218
au3	500	-.903	.109	.104	.218
au4	500	.306	.109	-1.128	.218
au5	500	-.680	.109	-.489	.218
au6	500	.239	.109	-1.253	.218

5.4 Measurement model and testing study model and hypotheses

Structural equation modelling using AMOS 21 software was employed in the current study as the principal statistical technique to analyse the data. Two stages were undertaken to analyse the science teachers' data.

5.4.1 Stage one: measurement model

A Structural Equation Model consists of two components, the measurement model and the structural equation model (Byrne, 2010). The measurement model is used to specify the indicators for each construct and assess the reliability of each construct for estimating the causal relationship between latent variables (Hair et al., 1998, p. 581). The latent variables imply the constructs of the model; these latent variables cannot be measured directly because they are theoretical constructs. Therefore the observed variables (questionnaire items) should be identified and validated by examining the significance of each indicator or observed variable as a measure for its latent variable.

The items for all the constructs of the proposed model were input at the first iteration, with each item representing a specific aspect of its construct (see Table 5.12). At the first iteration the model fit indicators were: CMIN/DF 2.351; AGFI .789; NNFI .912; RMR .049; RMSEA .052. The results showed that the model did not achieve an excellent fit because the AGFI value (0.789) was below the cut-off value (AGFI $\geq$ 0.80). Therefore, there were items that needed to be eliminated to improve the model fitness. The item eb1 "*Lack of resources (educational software)*" that measures external barriers (EB) was found to be problematic; the Squared Multiple Correlation (R^2) of this item (eb1) was 0.258 and this item (eb1) had a high residual covariation (62.40) with eb2 "*Lack of professional development opportunities on using ICT in teaching*". The decision was made to eliminate eb1 to solve this problem.

The results of model fit indicators after the second iteration were: CMIN/DF 2.336; AGFI .793; NNFI .915; RMR .049; RMSEA .052. The results indicated that the model did not achieve an excellent fit, because although the AGFI value (0.793) had increased it was below the recommended value (0.80). Therefore, there were additional items that need to be eliminated to improve the model fitness. The item u5 "*Helps students understand the lessons better*" that measures perceived usefulness (U) was found to be problematic; the Squared Multiple Correlation (R^2) of this item (u5) was 0.259. The decision was made to eliminate u5 to solve this problem.

The results of the third iteration for the model fit indicators were: CMIN/DF 2.223; AGFI .804; NNFI .922; RMR .050; RMSEA .050. The result showed that the model had improved but needed further adjustment to achieve a satisfactory fit. The item au4 "*How many lessons did you use ICT in your teaching in the week 7&8?*" that measures actual use of ICT in teaching (AU) was found to be problematic: the Squared Multiple Correlation (R^2) of this item (au4) was 0 .158 and this item (au4) had a high residual covariation with different items especially au6 "*How many lessons did you use ICT in your teaching in the week 11&12?*" and au2 "*How many lessons did you use ICT in your teaching in the week 3&4?*". The values of the residual covariation for item au4 with au6 and au2 were 120.69 and 111.917 respectively. The decision was made to eliminate au4 to address the problem.

The results after the fourth iteration for the model fit indicators were: CMIN/DF 2.087; AGFI 0.820; NNFI 0.932; RMR 0.046; RMSEA 0.047. The values of all the indicators were above the respective cut-off values, but the AGFI value needed to be greater the current value. The item cse2 *"Select and use educational software for a defined task according to quality, appropriateness, effectiveness, and efficiency"* that measures computer self-efficacy was found to be problematic; the Squared Multiple Correlation (R^2) of this item (cse2) was 0.453 which was the least among all the items used to measure the construct computer self-efficacy; and this item had a high residual covariation with different items especially cse1 *"Evaluate appropriately students' activities and tasks"*. The value of the residual covariation for item cse2 and cse1 was 34.886. Item cse2 was dropped.

After the fifth iteration, the results for the model fit indicators were: CMIN/DF 2.072; AGFI 0.824; NNFI 0.935; RMR 0.047; RMSEA 0.046. The results indicated improvement in the model fitness, but the AGFI value needed more improvement. The item sn5 *"Parent"* that measures the construct subjective norms was found to be problematic. This item (sn5) had a high residual covariation with different items especially sn6 *"Student"* and sn2 *"Principal"*, with the values 66.053 and 53.743 respectively. Item sn5 was dropped.

After the sixth iteration, the results for the model fit indicators were: CMIN/DF 1.993; AGFI 0.832; NNFI 0.941; RMR 0.046; RMSEA 0.045. The results showed improvement in the AGFI value. The item eb11 *"Lack of using ICT to measure student learning through high-stakes examinations"* that measures the construct external barriers (EB) was found to be problematic. This item (eb11) had high residual covariation with different items especially eb2 *"Lack of professional development opportunities on using ICT in teaching"* with the value 66.053. Item eb11 was dropped.

The seventh iteration results for the model fit indicators were: CMIN/DF 1.953; AGFI 0.837; NNFI 0.945; RMR 0.047; RMSEA 0.044. The results showed improvement in AGFI value. The item au2 *"How many lessons did you use ICT in your teaching in the week 3&4?"* that measures the construct actual use of ICT (AU) was found to be problematic. The item (au2) had a high residual covariation with different items especially au6 *"How many lessons did you use ICT in your teaching in the week 11&12?"* with the value 87.354. Item au2 was dropped.

After deleting item au2, the eighth iteration results for the model indicators were: CMIN/DF 1.898; AGFI 0.844; NNFI 0.950; RMR 0.045; RMSEA 0.042. The item au6 *"How many lessons did you use ICT in your teaching in the week 11&12?"* that measures actual use of ICT was deleted to improve the AGFI and GFI values, because the Squared Multiple Correlation (R^2) of this item was 0.125.

The results of the last iteration for the model fit indicators were: CMIN/DF 1.897; AGFI .846; NNFI .952; RMR .044; RMSEA .042. The model achieved a good fit and all the values of the model fit indicators were above the respective cut-off values. Figure 5.3 shows the measurement model (Final Iteration).

The results of confirmatory factor analysis for testing the measurement model confirmed that the measurement model had a good fit. The cut-off value of AGFI that is recommended for the current study was AGFI ≥ 0.8. Although there is some debate in the literature regarding the acceptable cut-off value for AGFI, most of the researchers accepted ≥ 0.90 as the cut-off value of AGFI. However, some researchers accepted ≥ 0.80 as the cut-off value of AGFI. AGFI is very sensitive to the model complexity and complicated models can contribute to reducing the required values of AGFI (Jais, 2007). The model investigated in the current study is considered to be a complex model because it consisted of 8 latent variables and 53 observed variables. Therefore, for the current study the value of .80 and above has been used as the cut-off value of AGFI (Jais, 2007).

Table 5.12: Iterations of the Measurement model and eliminated items in each stage

Iteration	Eliminated items	Reason to eliminate the items					
		CMIN/DF	AGFI	NNFI	RMR	RMSEA	
Indices criteria		1-2	≥0.80	≥0.95	≥0.80	≤0.08	
1	-	2.351	.789	.912	.049	.052	-
2	eb1	2.336	.793	.915	.049	.052	Squared Multiple Correlations 0.258. High residual covariation with (eb2) (62.40).
3	u5	2.223	.804	.922	.050	.050	Squared Multiple Correlations 0.259.
4	au4	2.087	.820	.932	.046	.047	High residual covariation with different items especially (au6) (120.69) and with (au2) (111.917). Squared multiple correlations (.158).
5	cse2	2.072	.824	.935	.047	.046	High residual covariation with different items especially (cse1) (34.886). The squared multiple correlations was the least among all the items used to measure this construct (0.453).
6	sn5	1.993	.832	.941	.046	.045	High residual covariation with different items especially (sn6) (66.053and (sn2) (53.743).
7	eb11	1.953	.837	.945	.047	.044	High residual covariation with different items especially (eb2) (64.550).
8	au2	1.898	.844	.950	.045	.042	High residual covariation with different items especially (au6) (87.354).
9	au6	1.897	.846	.952	.044	.042	Squared Multiple Correlations 0.125.

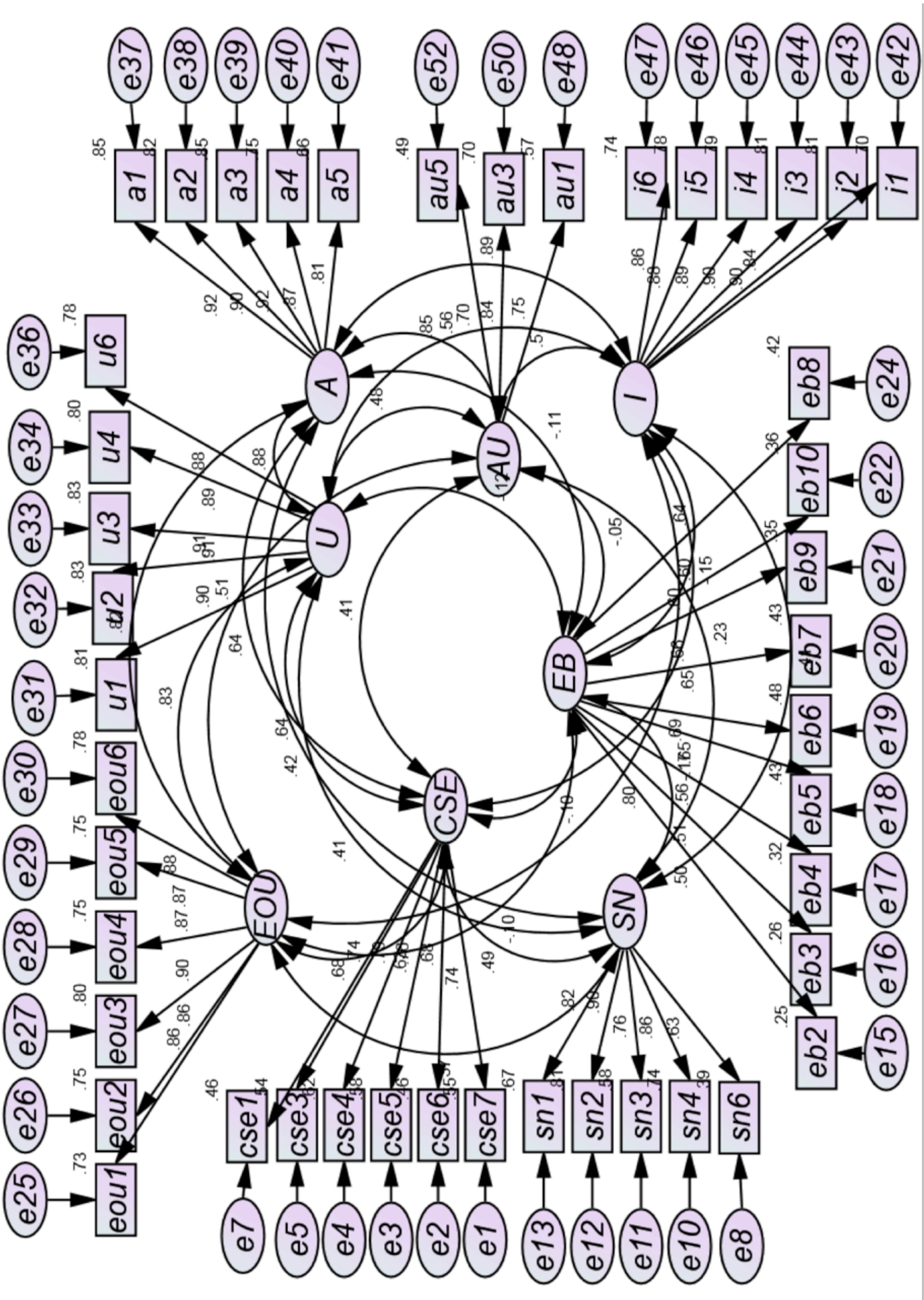


Figure 5.3: The measurement model (Final Iteration)

5.4.2 Stage two: Testing the Validity and reliability

It is important to study the validity and reliability of a measurement model because low values of validity and reliability may negatively affect the quality of data used in the next stage of analysis. The results that were demonstrated from testing the measurement model were employed to test the validity and reliability of the proposed model. Table 5.13 shows the results of performing CFA to test the measurement model. Cronbach's alpha, Construct Reliability, Convergent Validity (Standardized Regression Weights) (SRW), Composite Reliability (CR), squared multiple correlation (SMC) (item reliability), and average variance extracted (AVE), are the tests that were used to evaluate the reliability of the measurement model.

Suppose that we measure a quantity which is a sum of K components (*K-items* or *testlets*):.X= $Y_1 + Y_2 + Y_3 + \ldots + Y_k$. Cronbach's α is defined as

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

Where σ^2_X is the variance of the observed total test scores, and $\sigma^2_{Y_i}$ is the variance of component i for the current sample of persons. Cronbach's alpha reliability is important to test the internal consistency of the construct and the cut-off value for acceptability of Cronbach's alpha is 0.7. All the constructs of the proposed model exceeded the cut-off value of the Cronbach's alpha confirming a high level of reliability among the constructs. The values of these constructs as shown in Table 5.13 ranged between 0.804 and 0.955.

Construct Reliability is defined as:

$$CR = \frac{(\sum_{i=1}^{n} \lambda i)^2}{\left(\sum_{i=1}^{\lambda} \lambda i\right)^2 + (\sum_{i=1}^{n} \delta i)}$$

Where λ is the standardized factor loading, and δ is error variance. Construct Reliability refers to the measurement of the reliability of the construct. The cut-off value of the Construct Validity is 0.7. The results of the construct validity values of the current study constructs ranged between 0.817 and 0.960. These values were all above the cut-off value confirming a high level of reliability.

Squared Multiple Correlations (SMC) is defined as:

$$R^2 = 1 - \frac{\hat{\sigma}^2 \ residual}{\hat{\sigma}^2 \ endogenous}$$

Where $\hat{\sigma}^2 \ endogenous$ is the estimated (implied) variance of the endogenous variable and the $\hat{\sigma}^2 \ residual$ is the estimated (implied) variance of the associated residual variable. Squared Multiple Correlations (SMC) (item reliability) refers to the consistency of measurement among the items; it is useful to test the reliability of each item (observed variables). Items with R^2 above 0.5 demonstrate sufficient reliability (Bagozzi & Yi, 1988; Kline, 2011), and an R^2 value of 0.3 indicates acceptable items (Holms-Smith, 2011). The values of R^2 for items of the proposed model ranged between 0.318 and 0.849. The test results are presented in Table 5.13.

Average Variance Extracted is defined as:

$$AVE = \frac{\sum_{i=1}^{n} \lambda^2 i}{n}$$

Where λ is the standardized factor loading, and n is the number of the item. Average Variance Extracted was used to test the reliability of constructs. The constructs actual use, intention, attitude, ease of use, usefulness, computer self-efficacy, and subjective norms exceeded the acceptable level of 0.5. However, the value of Average Variance Extracted for external barriers was 0.388. This value was a result of the relatively low values of Squared Multiple Correlations. This value is not problematic because the other tests of reliability, Cronbach's alpha, and construct reliability supported the reliability of the construct external barriers.

Table 5.13: Results of CFA measurement model (Reliability and validity)

Items	Constructs		Estimate	SE	CR	P	SRW	SMC	Cronbach's alpha	Construct reliability	AVE
Computer Self-Efficacy											
cse1	<---	CSE	1.000				.680	.463	0.872	0.874	0.537
cse3	<---	CSE	.998	.068	14.663	***	.736	.542			
cse4	<---	CSE	1.059	.069	15.401	***	.788	.621			
cse5	<---	CSE	1.048	.069	15.088	***	.764	.584			
cse6	<---	CSE	.974	.073	13.398	***	.678	.459			
cse7	<---	CSE	1.025	.070	14.640	***	.744	.554			
Subjective norms											
sn1	<---	SN	1.328	.091	14.640	***	.818	.670	0.894	0.897	0.639
sn2	<---	SN	1.355	.088	15.472	***	.900	.810			
sn3	<---	SN	1.172	.082	14.234	***	.763	.582			
sn4	<---	SN	1.302	.084	15.474	***	.861	.742			
sn6	<---	SN	1.000				.626	.392			
External Barriers											
eb2	<---	EB	.754	.079	9.543	***	.504	.354	0.837	0.841	0.388
eb3	<---	EB	.769	.081	9.445	***	.507	.357			
eb4	<---	EB	.870	.083	10.498	***	.564	.318			
eb5	<---	EB	1.059	.089	11.874	***	.653	.426			
eb6	<---	EB	1.059	.084	12.640	***	.689	.475			
eb7	<---	EB	1.032	.084	12.305	***	.656	.431			
eb8	<---	EB	1.000				.644	.415			
eb9	<---	EB	.943	.085	11.107	***	.595	.355			
eb10	<---	EB	.951	.084	11.355	***	.602	.362			
Ease of use											
eou1	<---	EOU	1.012	.039	26.034	***	.856	.734	0.950	0.950	0.761
eou2	<---	EOU	.991	.037	26.481	***	.865	.748			
eou3	<---	EOU	.960	.034	28.451	***	.896	.803			
eou4	<---	EOU	.952	.036	26.735	***	.868	.753			
eou5	<---	EOU	1.000				.868	.754			
eou6	<---	EOU	.988	.036	27.782	***	.881	.776			
Perceived Usefulness											
u1	<---	U	1.018	.031	33.023	***	.902	.813	0.955	0.955	0.810
u2	<---	U	1.000				.910	.827			
u3	<---	U	.978	.029	33.920	***	.913	.833			
u4	<---	U	.950	.030	31.820	***	.894	.800			
u6	<---	U	.979	.032	30.766	***	.883	.779			
Attitude											
a1	<---	A	1.000				.920	.846	0.948	0.947	0.784
a2	<---	A	.953	.028	34.303	***	.903	.816			
a3	<---	A	.952	.027	35.718	***	.921	.849			
a4	<---	A	.895	.030	29.943	***	.866	.750			
a5	<---	A	.858	.033	26.072	***	.815	.663			
Intention											
i1	<---	I	.968	.040	24.454	***	.836	.699	0.952	0.960	0.768
i2	<---	I	.987	.035	28.082	***	.899	.808			
i3	<---	I	.990	.035	28.129	***	.898	.806			
i4	<---	I	1.003	.037	27.380	***	.887	.786			
i5	<---	I	1.003	.037	27.193	***	.881	.776			
i6	<---	I	1.000				.858	.736			
Actual Use											

Items	Constructs		Estimate	SE	CR	P	SRW	SMC	Cronbach's alpha	Construct reliability	AVE
au1	<---	AU	1.000				.699	.569	0.804	0.817	0.585
au3	<---	AU	1.025	.063	16.165	***	.836	.698			
au5	<---	AU	.926	.065	14.284	***	.755	.488			

CR: Critical Ratio; SRW: Standardized Regression Weight; SMC: Squared Multiple Correlation; Average Variance Extracted.

Convergent Validity is useful to test the validity of measurement. Convergent Validity (Standardized Regression Weights) refers to the consistency between the construct and its observed variables. In other words, it indicates the extent to which the item measures what it is supposed to measure (construct). The factor loading of each item with estimate of .50 or higher was considered to show significant validity. The values of the factor loading for the items of the current study were between 0.504 and 0.921, confirming the validity of the latent variables. Also, the critical Ratios (CR) of these items were between 9.445 and 35.718 which were above the cut-off value of 1.96 and this was considered to show significant regression validity (see Table 5.13).

The analysis of discriminant validity depends on measuring the square root of average variance extracted for each construct and the result for each construct should be more than its correlation with other constructs (Liang, Saraf, Hu, & Xue, 2007). The results of the discriminant validity analysis of the measurement model demonstrated a satisfactory level of discriminant validity as shown in Table 5. 14

Table 5.14: Analysis of discriminant validity

Constructs	CSE	SN	EB	EOU	U	A	I	AU
CSE	0.732							
SN	.495	0.799						
EB	-.102	-.173	0.622					
EOU	.628	.373	-.045	0.872				
U	.642	.414	-.123	.833	0.90			
A	.635	.424	-.114	.821	.877	0.885		
I	.652	.415	-.147	.802	.849	.892	0.876	
AU	.414	.225	-.045	.507	.477	.562	.572	0.764

Stage two of the analysis tested the reliability and validity of the measurements used. Five tests were employed to evaluate the reliability: Cronbach’s alpha, Construct Reliability, Composite Reliability (CR), squared multiple correlation (SMC) (item reliability), and average variance extracted (AVE). The results of Confirmatory Factor Analysis (CFA) demonstrated the reliability of the instrument used in the current study.

Two tests were employed to assess the validity of measurement: Convergent Validity (Standardized Regression Weights) (SRW), and Discriminant Validity. The results indicated that the measurement was valid for the constructs of the proposed model.

5.4.3 Examine the structural model and hypotheses

The proposed Information and Communication Technology Acceptance Model (ICTAM) was designed to achieve the critical objective of predicting science teachers’ use of ICT. Eight constructs were selected to evaluate the acceptance of using ICT in teaching from the science teachers’ point of view. The proposed model can be considered a complex model due to the availability of eight latent variables and 45 observed variables. Also there were different paths among the latent variables, and relationships between latent variables were not limited to the direct effects, but also included the mediation role of some latent variables.

5.4.3.1 Evaluating the initial model

The first test for the initial model was to test the direct relationships between latent variables (constructs). The results of the overall fit for the proposed model are shown in Figure 5.4. The model fit indices that emerged from testing the latent variables of the proposed model were: CMIN/DF 1.893; AGFI 0.847; NNFI 0.952; RMR 0.045; RMSEA 0.042. The results of regression tests confirmed the essential role of subjective norms in affecting the perceptions of external barriers, computer self-efficacy, usefulness, and attitude. Subjective norms significantly impacted the perceptions of external barriers, and the standardized regression coefficient (β) was -0.059 with critical ratio (t-value) -3.295 at significant p value < 0.001. Computer self-efficacy was also affected by subjective norms and the standardized regression coefficient was 0.388 with critical ratio 9.292 at significant level p < 0.001. Subjective norms significantly impacted perceptions of usefulness (β = 0.063, t = 1.971, p = 0.049).

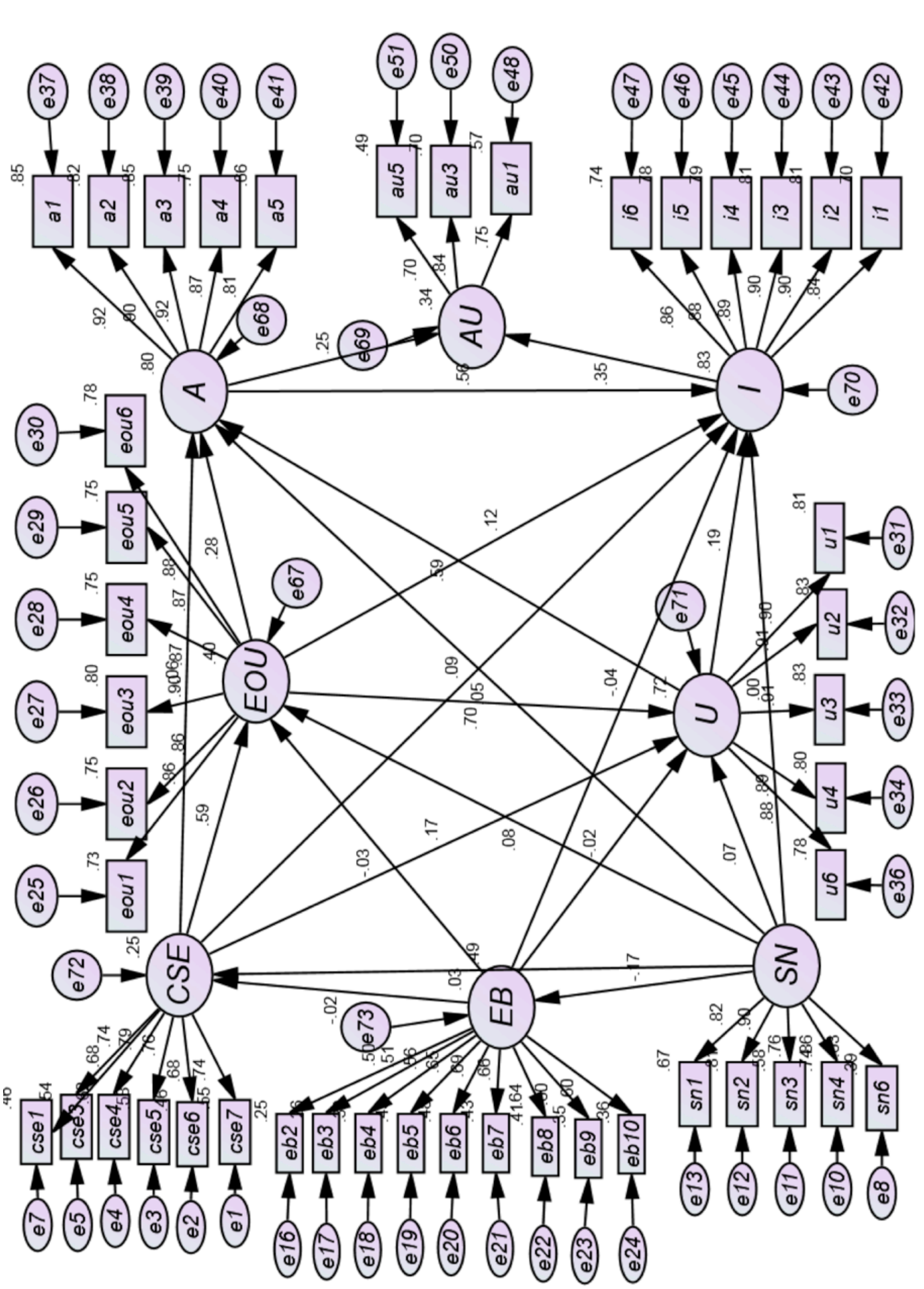


Figure 5.4: Results of testing the initial model (without considering mediation)

The results of the regression test also confirmed the essential role of computer self-efficacy in affecting ease of use, usefulness, attitude, and intention. Computer self-efficacy significantly affected ease of use, and the standardized regression coefficient (β) was 0.687 with critical ratio (t-value) 10.380 at significant p value < 0.001. Usefulness was affected significantly by computer self-efficacy (β 0.200, t-value 3.868, and p < 0.001). Behavioural intention was significantly affected by computer self-efficacy (β = 0.103, t = 2.617, p = 0.009).

The results of the regression test also confirmed the essential role of ease of using ICT in teaching in affecting usefulness, attitude, and behavioural intention. Ease of use significantly affected usefulness of using ICT in teaching, and the standardized regression coefficient (β) was 0.725 with critical ratio (t-value) 16.122, and p value < 0.001. Attitude toward using ICT in teaching was affected significantly by ease of using ICT in teaching (β = 0.291, t = 5.585, p < 0.001). Ease of use significantly affected behavioural intention (β = 0.108, t = 2.373, p = 0.018).

Usefulness of ICT significantly affected attitude (β = 0.598, t = 11.246, p < 0.001). Behavioural intention was affected significantly by usefulness (β = 0.175, t = 3.250, p = 0.01).

Attitude toward using ICT in teaching significantly affected behavioural intention, and the standardized regression coefficient (β) was 0.499 with critical ratio (t-value) 9.337, and p value < 0.001. Actual use of ICT in teaching was affected significantly by attitude toward using ICT in teaching, and the standardized regression coefficient (β) was 0.195 with critical ratio (t-value) 2.189, and p value 0.029.

Behavioural intention significantly affected actual use of ICT, and the standardized regression coefficient (β) was 0.314 with critical ratio (t-value) 3.118, and p value 0.002.

According to the proposed model, two constructs were hypothesized as determinants of ease of use: subjective norms and external barriers. The direct effects of these two constructs on ease of use were insignificant: subjective norms (β = 0.073, t = 1.663, p = 0.096); and external barriers (β = -0.070, t = -0.619, p = 0.536).

Also, subjective norms and external barriers were hypothesized as determinants of behavioural intention. The direct effects of these two constructs on behavioural intention were insignificant: subjective norms (β = -0.001, t = -0.038, p = 0.970); and external barriers (t = -0.095, t = -1.514, p = 0.130).

Moreover, subjective norms and computer self-efficacy were hypothesized as determinants of attitude toward using ICT. The direct effects of these two constructs on attitude were insignificant: subjective norms (β = 0.045, t = 1.599, p = 0.110); and computer self-efficacy (β = 0.077, t = -1.651, p = 0.099).

The external barriers construct was hypothesized as a determinant of usefulness and computer self-efficacy. The direct effect of external barriers on usefulness was insignificant (β = -0.070, t = -0.840, p = 0.401). Also, the direct effect of external barriers on computer self-efficacy was insignificant (β = -0.038, t = -0.346, p = 0.730) (see Table 5.15).

Table 5.15: Regression Results of the Initial Model

			Estimate	SE	CR	P
EB	<---	SN	-.059	.018	-3.295	***
CSE	<---	SN	.388	.042	9.292	***
CSE	<---	EB	-.038	.111	-.346	.730
EOU	<---	CSE	.687	.066	10.380	***
EOU	<---	SN	.073	.044	1.663	.096
EOU	<---	EB	-.070	.113	-.619	.536
U	<---	CSE	.200	.052	3.868	***
U	<---	SN	.063	.032	1.971	.049
U	<---	EB	-.070	.083	-.840	.401
U	<---	EOU	.725	.045	16.122	***
A	<---	U	.598	.053	11.246	***
A	<---	EOU	.291	.052	5.585	***
A	<---	CSE	.077	.046	1.651	.099
A	<---	SN	.045	.028	1.599	.110
I	<---	A	.499	.053	9.337	***
I	<---	U	.175	.054	3.250	.001
I	<---	EOU	.108	.045	2.373	.018
I	<---	CSE	.103	.039	2.617	.009
I	<---	SN	-.001	.024	-.038	.970
I	<---	EB	-.095	.063	-1.514	.130
AU	<---	I	.314	.101	3.118	.002
AU	<---	A	.195	.089	2.189	.029

5.4.3.2 Evaluating the mediation role of Ease of Use

The partial mediation approach was used to assess the relationships between the model variables. Social science researchers have frequently adopted that approach in their studies of the relationships between the constructs to study the partial mediation (Baron & Kenny, 1986). This approach was adopted in the current study as the baseline model to evaluate the causal relationships between latent variables (constructs) and to find if the relationships between factors have achieved the three conditions of partial mediation. Accordingly the study assumed that the effect of computer self-efficacy (CSE) and subjective norms (SN) on attitude (A) is mediated by ease of use (EOU). However, these assumptions were not achieved because in the partial mediation the direct effect of predictor variables (subjective norms and computer self-efficacy) on the dependent variable (attitude) must be significant (Baron & Kenny, 1986), and this condition was not achieved in the model as the effects of subjective norms and computer self-efficacy on attitude were insignificant. More details are shown in Table 5.15.

In view of the above results, there was a possibility that the relationship between subjective norms (SN) and computer self-efficacy (CSE) and attitude (A) were fully mediated by ease of use (EOU). Therefore, the full mediation model was examined.

Baron and Kenny (1986) explained the conditions that should be followed to examine the mediation. Firstly, the dependent variable should be affected significantly by the predictor variable. Secondly, the mediator variable should be affected significantly by the predictor variable. Thirdly, the dependent variable should be affected significantly by the mediator variable. Fourthly, the dependent variable should not be affected significantly by the predictor variable when the mediator variable is controlled (full mediation) or the effect should significantly reduce (partial mediation) (Baron and Kenny, 1986).

Hair et al. (2010) suggested two stages: ***Stage one*** is equivalent to the conditions one to three of Baron and Kenny (1986). In this stage the individual relationships between the constructs should be tested and these relationships must be significant. In applying these conditions to the current study:

- ❖ Subjective norms (SN) and computer self-efficacy (CSE) must significantly affect attitude (A).
- ❖ Subjective norms (SN) and computer self-efficacy (CSE) must significantly affect ease of use (EOU).
- ❖ Ease of use (EOU) must significantly affect attitude (A).

The relationships between the predictor variables, mediator variable, and dependent variable were tested and the results demonstrated that the first three conditions of examining the mediation were achieved which supported the three conditions of mediation. The results of testing the effect of subjective norms and computer self-efficacy (predictor variables) on attitude (A) were significant. For condition one: computer self-efficacy affected attitude significantly (β = 0.132, t = 3.046, p = 0.002); and subjective norms affected attitude significantly (β = 0.066, t = 2.400, p = 0.016). For condition two: computer self-efficacy affected ease of use significantly (β = 0.739, t = 12.144, p = 0.001); and subjective norms affected ease of use significantly (β = 0.367, t = 8.476, p = 0.001). For condition three: ease of use affected attitude significantly (β = 0.296, t = 5.876, p = 0.001) (see Table5.16).

Table 5.16: Conditions for the mediation role of EOU between CSE, EB, SN and A

Conditions 1	Results	Achieved/not achieved
CSE must impact A.	(β .132, .C.R 3.046, P value .002)	Achieved
SN must impact A.	(β .066, .C.R 2.400, P value .016)	Achieved
Conditions 2		
CSE must impact EOU	(β .739, .C.R 12.144, P value .001)	Achieved
SN must impact EOU	(β .367, .C.R 8.476, P value .001)	Achieved
Conditions 3		
EOU must impact A	(β .296, .C.R 5.876, P value .001)	Achieved

Stage two includes two sub-stages. Sub-stage one is to establish an initial model with only one direct impact between the predictor variable and the dependent variable. Sub-stage two is to estimate a second model that includes the mediator variable, the impact of the predictor variable on the mediator, and the impact of the mediator on the dependent variable. The current study tested those two models and then compared the relationship between these two models to identify the type of mediation. Table 5.17 shows the condition of relationship and type of mediation.

Table 5.17: Conditions of relationships to identify the type of mediation

Condition	Mediation outcome
Relationship between predictor factor and dependent factor after adding the mediator factor to the model as an additional predictor Significant and unchanged	No Mediation
Relationship between predictor factor and dependent factor after adding the mediator factor to the model as an additional predictor Reduced but remains significant	Partial Mediation
Relationship between predictor factor and dependent factor after adding mediator factor to the model as an additional predictor Reduces to a point where it is not statistically significant	Full Mediation

Sub-stage one was employed in the initial model to estimate only the direct effect between predictor variables and the dependent variable. The results of the examination indicated that the effect of computer self-efficacy on attitude (A) was significant. However, the effect of subjective norms (SN) on attitude (A) was insignificant. The results of the test are shown in Table 5.18.

Table 5.18: Regression Weights of the initial model with only the direct effects of SN, and CSE on A

		Estimate	SE	CR	p	Label
EB	<---	SN	-.059	.018	-3.295	***
CSE	<---	SN	.378	.041	9.176	***
CSE	<---	EB	-.039	.108	-.358	.720
U	<---	CSE	.230	.050	4.646	***
U	<---	SN	.066	.032	2.055	.040
U	<---	EB	-.073	.083	-.869	.385
U	<---	EOU	.725	.042	17.375	***
A	<---	U	.598	.053	11.233	***
A	<---	EOU	.291	.050	5.823	***
A	<---	CSE	.090	.045	2.008	.045
A	<---	SN	.046	.028	1.629	.103
I	<---	A	.499	.053	9.328	***
I	<---	U	.175	.054	3.244	.001
I	<---	EOU	.115	.044	2.639	.008
I	<---	CSE	.105	.038	2.769	.006
I	<---	SN	-.001	.024	-.038	.970
I	<---	EB	-.095	.063	-1.511	.131
AU	<---	I	.314	.101	3.118	.002
AU	<---	A	.195	.089	2.189	.029

Note: Significant at: *** $P < 0.001$

Sub-stage two was employed to examine the model with the mediator variable (ease of use), the effect of predictor variables (subjective norms and computer self-efficacy) on the mediator variable, and the effect of the mediator variable (ease of use) on the dependent variable (attitude). Estimating this model was done earlier at the stage of testing the initial model (proposed model), because the model was developed fundamentally for partial mediation (see section 5.4.3.1; Figure 5.4). The results of this stage demonstrated that significant changes occurred in the relationship between computer self-efficacy (CSE) and attitude (A). However, the results of this stage demonstrated that no changes occurred in the relationship between subjective norms (SN) and attitude (A). Table 5.19 shows the results of the comparison between the initial model without the mediation of attitude (A) and the initial model with the mediation of attitude (A).

Table 5.19: Comparison of the initial model without and with mediation (Attitude)

			Without mediation (Direct)		With mediation		The type of mediation
			CR	P	CR	P	
A	<---	CSE	2.008	.045	1.499	.134	Full
A	<---	SN	1.629	0.103	1.599	.110	No Mediation

Hairs (2010) stated that if the relationship between the predictor factor and the dependent factor was significant, and then reduced to a point where it is not significant after adding the mediator factor as an additional predictor, then the relationship between the predictor factor and the dependent factor is fully mediated by the mediator factor. However, if the relationship between the predictor factor and the dependent factor was significant or insignificant, and then did not change after adding the mediator factor as an additional predictor, then the relationship between predictor variable and dependent variable is not mediated by the mediator variable (Hairs, 2010).

The study hypothesized that the effect of computer self-efficacy on attitude is mediated by ease of use. The results from the initial model indicated the relationships between the computer self-efficacy (predictor variable) and attitude (dependent variable) was statistically significant in the initial model with only direct effect between computer self-efficacy and attitude. This relationship became insignificant after adding ease of use (mediator variable). Accordingly, this result demonstrated that the relationship between computer self-efficacy (predictor variable) and attitude (dependent variable) was fully mediated by ease of use (mediator variable). Consequently, this result tended to support the full mediation model (see Figure 5.5 Direct effect without EOU mediation, and Figure 5.6 the model after considering the mediation role of EOU) (see Table 5.20 Regression Weights of the model after testing the mediation role of EOU).

Also the study hypothesized that the effect of subjective norms on attitude is mediated by ease of use. However, the results from the initial model with only direct effect between subjective norms (predictor variable) and attitude (dependent variable) showed that the relationship between subjective norms (predicator variable) and attitude (dependent variable) was statistically insignificant. This relationship remained insignificant after linking subjective norms (predicator variable) with ease of use (mediator variable) and linking ease of use (mediator variable) with attitude (dependent variable). The relationship between subjective norms and attitude was not significant after adding ease of use (mediator factor). Accordingly, the mediation role, partial or full, of ease of use between subjective norms and attitude was not accepted. Consequently, this result tended to support no mediation model (see Figure 5.6, Figure 5.5 and Table 5.20).

Table 5.20: Regression Weights after testing the mediation role of EOU

			Estimate	SE	CR	P
EB	<---	SN	-.059	.018	-3.295	***
CSE	<---	SN	.389	.042	9.308	***
CSE	<---	EB	-.038	.111	-.342	.732
EOU	<---	CSE	.689	.066	10.424	***
EOU	<---	SN	.071	.044	1.628	.104
EOU	<---	EB	-.070	.113	-.620	.535
U	<---	CSE	.205	.052	3.958	***
U	<---	SN	.062	.032	1.934	.053
U	<---	EB	-.070	.083	-.842	.400
U	<---	EOU	.722	.045	16.070	***
A	<---	U	.617	.052	11.788	***
A	<---	EOU	.310	.051	6.050	***
A	<---	SN	.062	.026	2.358	.018
I	<---	A	.501	.054	9.356	***
I	<---	U	.173	.054	3.189	.001
I	<---	EOU	.106	.046	2.328	.020
I	<---	CSE	.108	.039	2.751	.006
I	<---	SN	-.002	.024	-.089	.929
I	<---	EB	-.095	.063	-1.514	.130
AU	<---	I	.317	.101	3.152	.002
AU	<---	A	.193	.089	2.168	.030

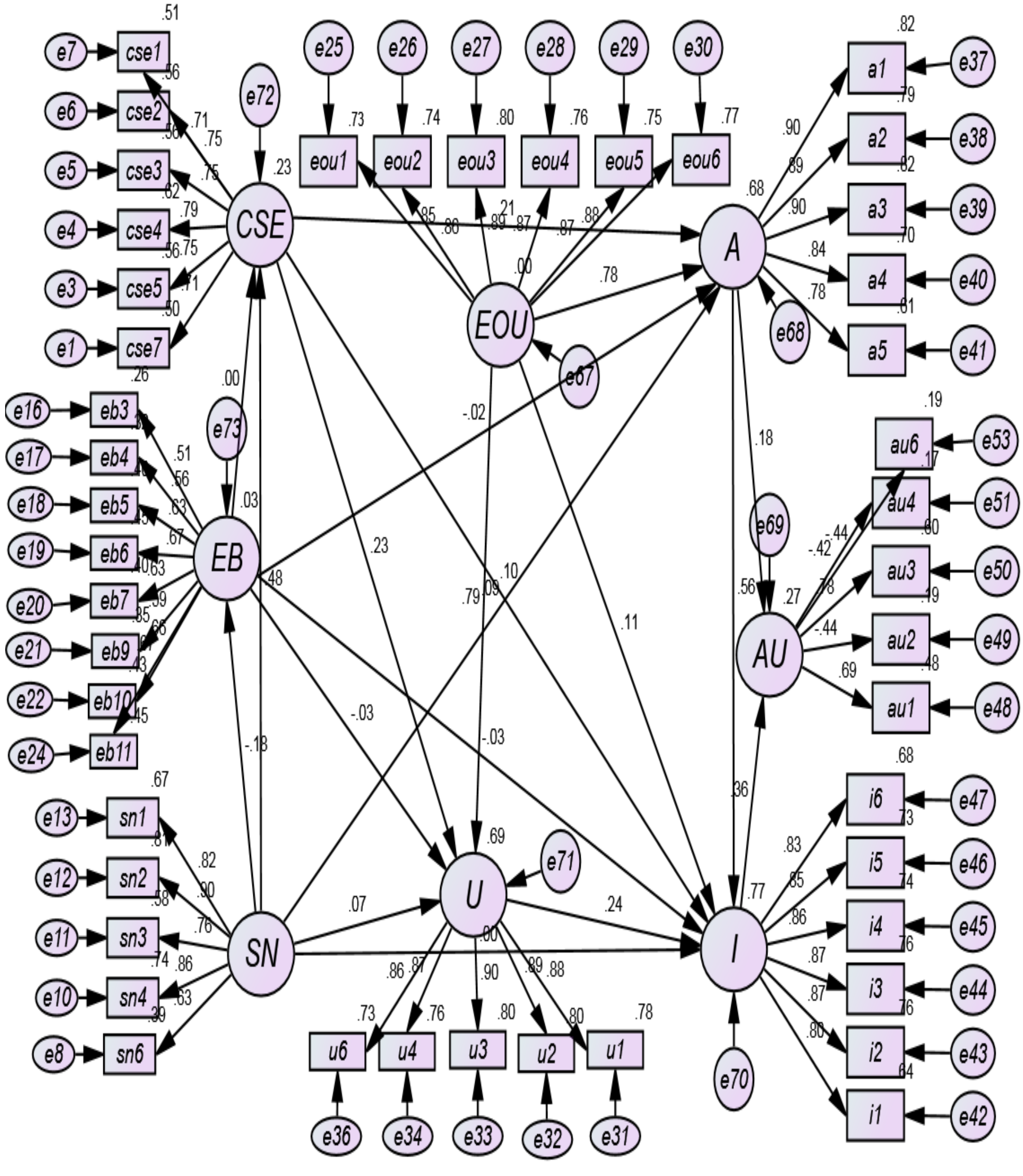


Figure 5.5: Direct effect without EOU mediation

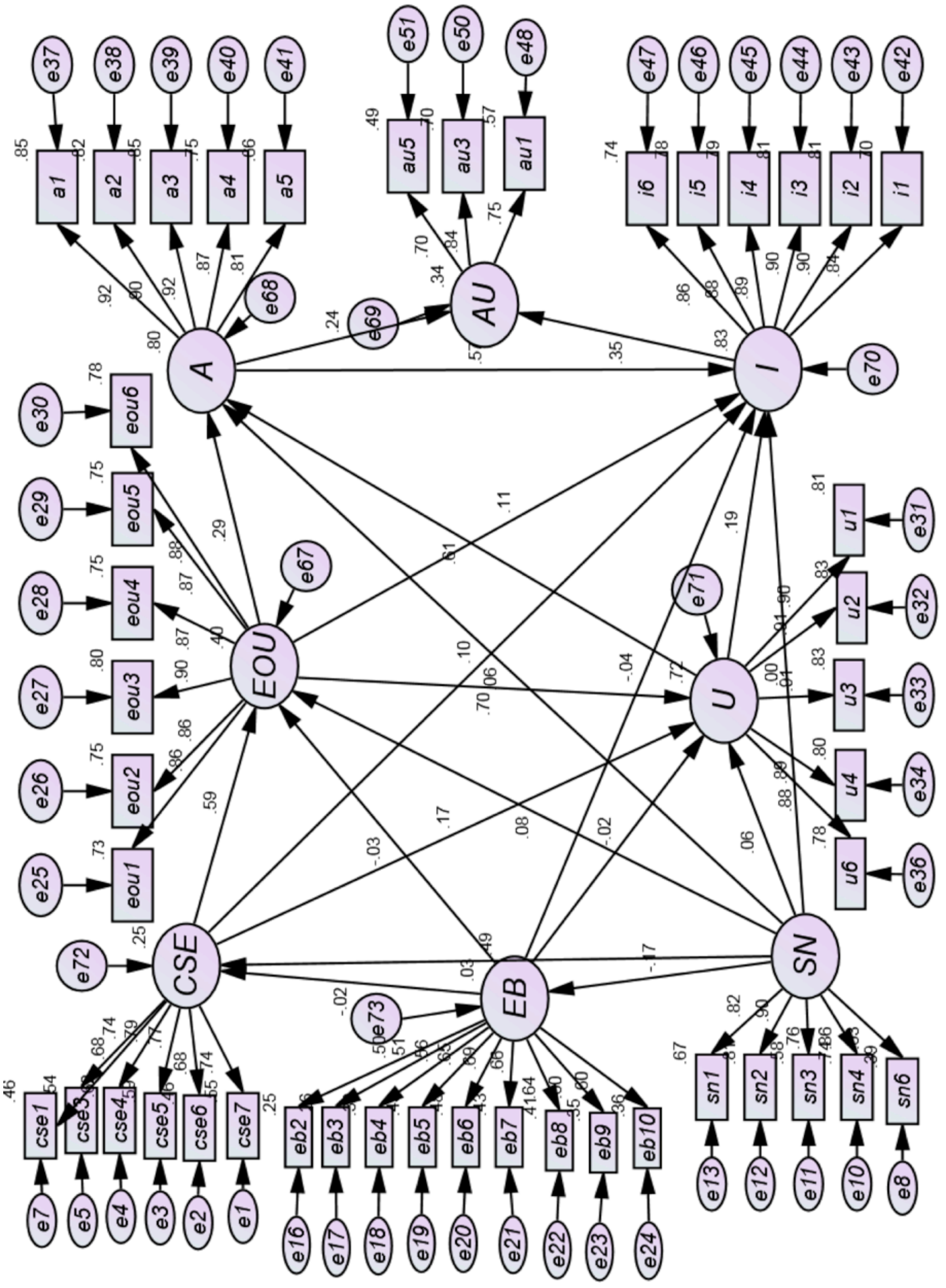


Figure 5.6: The model after considering the mediation role of EOU

5.4.3.3 Evaluating the mediation role of Perceived Usefulness

Computer self-efficacy, attitude, usefulness, ease of use, external barriers and subjective norms were hypothesized as determinants of Behavioural Intention. The results of the regression analysis indicated that computer self-efficacy ($\beta = 0.103$, $t = 2.617$, $p = 0.009$), ease of use ($\beta = 0.108$, $t = 2.373$, $p = 0.018$), attitude ($\beta = 0.499$, $t = 9.337$, $p < 0.001$), and usefulness ($\beta = 0.175$, $t = 3.250$, $p = 0.001$) affected behavioural intention significantly. However, external barriers ($\beta = -0.095$, $t = 0.063$, $p = 0.130$) and subjective norms ($\beta = -0.001$, $t = 0.024$, $p = 0.970$) affected behavioural intention insignificantly (see Table 5.15).

The study hypothesised that the impact of computer self-efficacy, external barriers, and subjective norms on behavioural intention is mediated by perceived usefulness. The three partial mediation roles were accepted for the relationships between computer self-efficacy (predictor), intention (dependent), and usefulness (mediator). Computer self-efficacy (predictor) significantly impacted intention (dependent), computer self-efficacy (predictor) significantly impacted usefulness, and usefulness significantly impacted intention (dependent). The three conditions were achieved (see Table 5.15). However, the three partial mediation roles for the causal relationships between external barriers (predictor), intention (dependent), and usefulness (mediator) were not all achieved. External barriers (predictor) significantly affected intention (dependent), and usefulness (mediator) significantly affected intention (dependent, but external barriers (predictor) insignificantly affected usefulness (mediator) (see Table 5.15).

Moreover, the three partial mediation roles for the causal relationships between subjective norms (predictor), intention (dependent), and usefulness (mediator) were not all achieved. Subjective norms (mediator) significantly affected usefulness, and usefulness (mediator) significantly affected intention (dependent). However, subjective norms (predictor) insignificantly affected intention (dependent) (see Table 5.15).

In view of the above results, there was a possibility that the relationship between subjective norms (SN), external barriers (EB), and computer self-efficacy (CSE) and attitude were fully mediated by ease of use (EOU). Therefore, the full mediation model was examined.

Stage one: in this stage the individual relationships between the constructs should be tested and these relationships must be significant. In applying these conditions to the current study:

- ❖ Subjective norms (SN), external barriers (EB), and computer self-efficacy (CSE) must significantly affect intention (I).
- ❖ Subjective norms (SN), external barriers (EB), and computer self-efficacy (CSE) must significantly affect usefulness (U).
- ❖ Usefulness (U) must significantly affect intention (I).

The relationships between the predictor variables, mediator variable, and dependent variable were tested and the results demonstrated that the first three conditions of examining the mediation were not all achieved which did not support the three conditions of mediation. For the first condition the results of testing the effect of computer self-efficacy, external barriers, and subjective norms (predictor variables) on intention (I) were not all significant. Computer self-efficacy affected intention significantly, while subjective norms and external barriers affected intention insignificantly; and the results were: computer self-efficacy (β = 0.121, t = 3.253, p = 0.001), external barriers (β = -0.109, t = -0.720, p = 0.86), and subjective norms (β = 0.030, t = 1.313, p = 0.189). For the second condition the results of testing the effect of computer self-efficacy, external barriers, and subjective norms (predictor variables) on usefulness (mediator variable) were not all significant. Computer self-efficacy and subjective norms affected usefulness significantly, while external barriers affected usefulness insignificantly; and the results were: computer self-efficacy (β = 0.243, t = 5.023, p = 0.001), subjective norms (β = 0.115, t = 3.894, p = 0.001), and external barriers (β = -0.115, t = -3.55, p = 0.001). Finally, for the third condition the result of testing the effect of usefulness on intention was significant (β = 0.193, t = 3.550, p = 0.001) (see Table 5.21).

Table 5.21: Conditions of examining the mediation role of U between CSE, EB, SN and A

Conditions 1	β	CR	p	Achieved/not achieved
CSE must impact I.	0.121	3.253	0.001	Achieved
EB must impact I.	-0.109	1.720	0.860	Not Achieved
SN must impact I.	0.030	1.313	0.189	Not Achieved
Conditions 2				
CSE must impact U	0.243	5.023	0.001	Achieved
EB must impact U	-0.115	-1.355	0.176	Not Achieved
SN must impact U	0.115	3.894	0.001	Achieved
Conditions 3				
U must impact I	0.193	3.550	0.001	Achieved

Stage two comprises two sub-stages. In sub-stage one an initial model is formed with only one direct effect between the predictor factor and the dependent factor. In sub-stage two a second model is estimated and this second model includes the mediator variable, the effect of the predictor variable on the mediator, and the effect of the mediator on the dependent variable. These two models were tested in the current study, and then the relationships between these two models were compared to identify the type of mediation. Table 5.17 shows the condition of relationship and type of mediation.

Sub-stage one estimated only the direct effect between predictor variables and the dependent variable. The results of the test indicated that the effect of computer self-efficacy (CSE) on behavioural intention (I) was significant. However, the effect of subjective norms (SN) and external barriers (EB) on intention (I) was insignificant. The results of the test are shown in Table 5.22.

Table 5.22: Regression Weights: direct effect without mediation of SN, CSE, and EB on U

			Estimate	SE	CR	p
EB	<---	SN	-.059	.018	-3.294	***
CSE	<---	SN	.389	.042	9.298	***
CSE	<---	EB	-.038	.110	-.347	.729
EOU	<---	CSE	.703	.066	10.646	***
EOU	<---	SN	.077	.043	1.782	.075
EOU	<---	EB	-.077	.111	-.694	.488
U	<---	EOU	.869	.040	21.621	***
A	<---	U	.605	.053	11.505	***
A	<---	EOU	.318	.052	6.065	***
A	<---	SN	.068	.026	2.578	.010
I	<---	A	.501	.053	9.365	***
I	<---	EOU	.101	.048	2.136	.033
I	<---	CSE	.111	.039	2.819	.005
I	<---	EB	-.096	.063	-1.526	.127
I	<---	SN	-.002	.024	-.079	.937
I	<---	U	.177	.054	3.296	***
AU	<---	I	.317	.101	3.154	.002
AU	<---	A	.193	.089	2.168	.030

Sub-stage two examined the model with the mediator variable (usefulness), the effect of predictor variables (computer self-efficacy, external barriers, and subjective norms) on the mediator variable (usefulness); and the effect of the mediator variable (usefulness) on the dependent variable (intention). Examining the model with mediation was accomplished earlier at the stage of testing the initial model (proposed model), because the model was developed fundamentally for partial mediation (see section 5.4.3.1; Figure 5.4). The results indicated that no changes occurred in the relationship between computer self-efficacy (CSE), external barriers (EB), and subjective norms (SN), and attitude (A). Table 5.23 shows the results of the comparison between the initial model without the mediation of intention (I) and the initial model with the mediation of intention (I).

Table 5.23.Comparison between the initial with mediation and without

			Without mediation (Direct)		**With mediation**		**The type of mediation**
			CR	**p**	**CR**	**p**	
I	<---	CSE	2.819	.005	2.751	.006	No Mediation
I	<---	EB	-1.526	.127	-1.514	.130	No Mediation
I	<---	SN	-.079	.937	-.089	.929	No Mediation

The current study hypothesized that the effects of computer self-efficacy, external barriers, and subjective norms on intention is mediated by usefulness. The results from the initial model indicated the relationships between the computer self-efficacy (predictor variable) and intention (dependent variable) was statistically significant in the initial model with only direct effect between computer self-efficacy and intention. This relationship remained significant after adding usefulness (mediator variable). Accordingly, this result demonstrated that the relationship between computer self-efficacy (predictor variable) and intention (dependent variable) was not mediated by usefulness (mediator variable). Consequently, this result tended to support a model with no mediation (see Figure 5.7).

Also the study hypothesized that the effect of subjective norms on intention is mediated by usefulness. However, the results from the initial model with only direct effect of subjective norms (predictor variable) on intention (dependent variable) showed that the relationship between subjective norms (predictor variable) and intention (dependent variable) was statistically insignificant. This relationship remained insignificant after linking subjective norms (predictor variable) with usefulness (mediator variable) and linking usefulness (mediator variable) with intention (dependent variable). The relationship between subjective norms and intention remained insignificant after adding usefulness (mediator factor). Accordingly, the mediation role, partial or full, of usefulness between subjective norms and intention was not achieved. Consequently, this result tended to support a model with no mediation (see Figure 5. 7).

Moreover, the study hypothesized that the effect of external barriers on intention is mediated by usefulness. The results from the initial model with only direct effect of external barriers (predictor variable) on intention (dependent variable) showed that the relationship between external barriers (predictor variable) and intention (dependent variable) was statistically insignificant. This relationship remained insignificant after linking external barriers (predictor variable) with usefulness (mediator variable) and linking usefulness (mediator variable) with intention (dependent variable). The relationship between external barriers and intention remained insignificant after adding usefulness (mediator factor). Accordingly, the mediation role, partial or full, of usefulness between external barriers and intention was not achieved. Consequently, this result tended to support a no mediation model (see Figure 5.7 Direct effect without U mediation, and Figure 5.8 The final study model after considering the results of meditation role of EOU and U) (see Table 5.24).

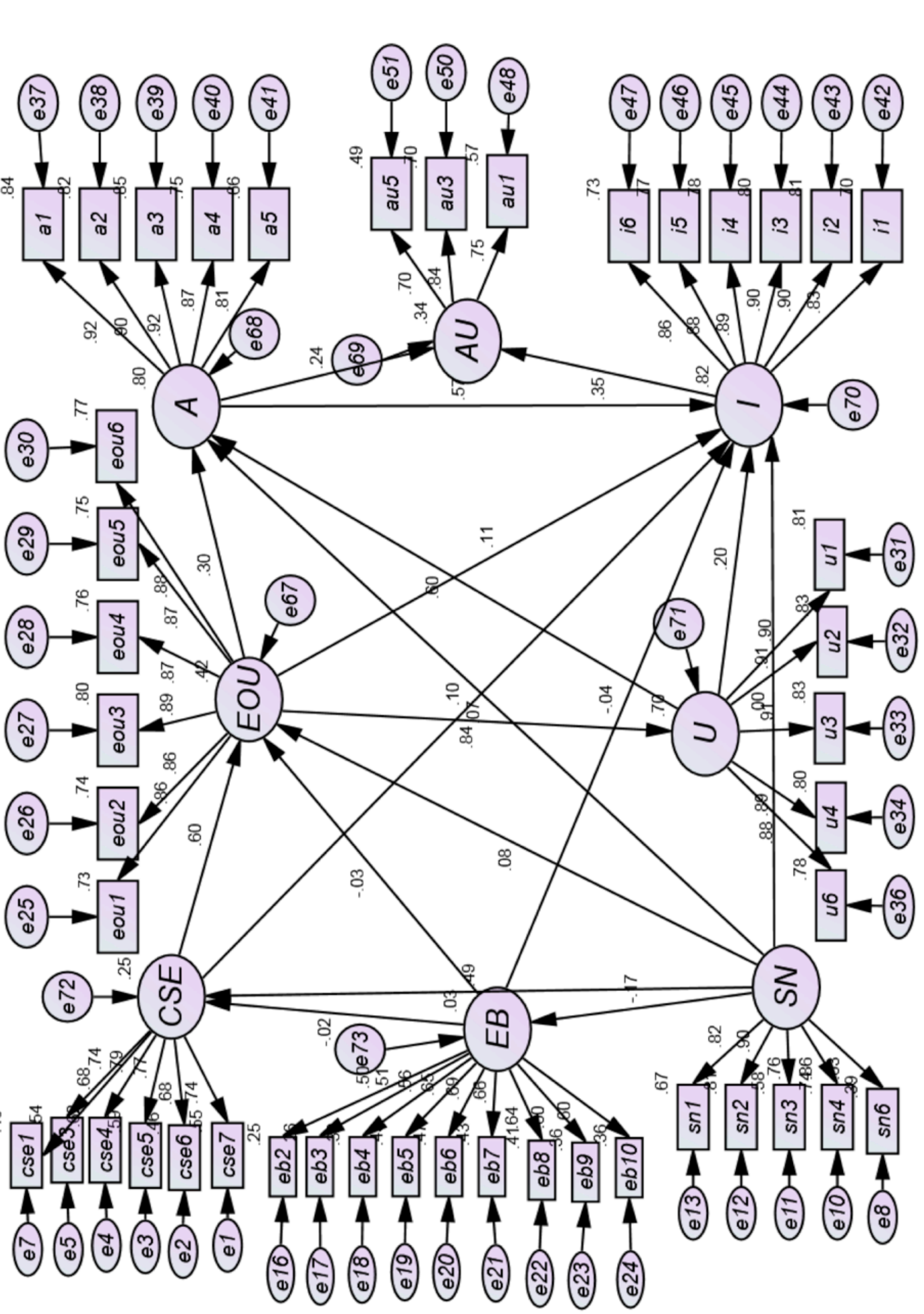


Figure 5.7: Direct effect without U mediation

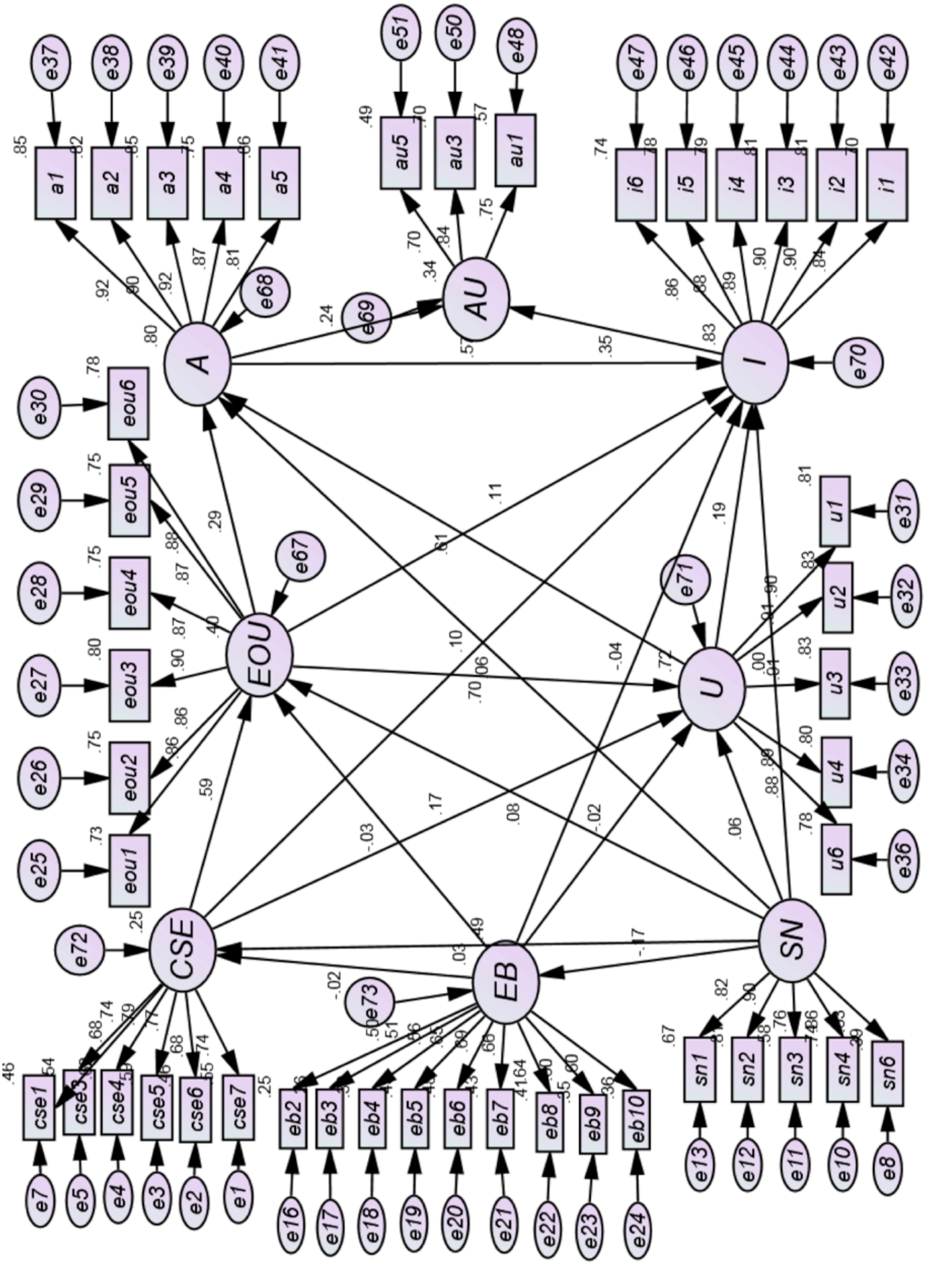


Figure 5.8: Final model after considering the results of meditation role of EOU and PU

5.4.3.4 Test of the final model

Mediation of usefulness was not supported in regard to the relationship between computer self-efficacy, external barriers, and subjective norms with behavioural intention. However, mediation of ease of use was supported only in regard to the relationship between computer self-efficacy and attitude, but was not supported in regard to the relationship between subjective norms and attitude. The final study model after considering the results of the mediation role of ease of use and usefulness is shown in Figure 5.17. The model achieved a good fit, and the results were as follows: CMIN/DF 1.894; AGFI 0.847; NNFI .952; RMR .045; RMSEA .042. The results of regression analysis between the constructs of the final model are shown in Table 5.24.

Table 5.23: Regression Weights of the final model after testing the mediation role

			Estimate	SE	CR	p	Significance
EB	<---	SN	-.059	.018	-3.295	***	Significant
CSE	<---	SN	.389	.042	9.308	***	Significant
CSE	<---	EB	-.038	.111	-.342	.732	Not Significant
EOU	<---	CSE	.689	.066	10.424	***	Significant
EOU	<---	SN	.071	.044	1.628	.104	Not Significant
EOU	<---	EB	-.070	.113	-.620	.535	Not Significant
U	<---	CSE	.205	.052	3.958	***	Significant
U	<---	SN	.062	.032	1.934	.053	Significant
U	<---	EB	-.070	.083	-.842	.400	Not Significant
U	<---	EOU	.722	.045	16.070	***	Significant
A	<---	U	.617	.052	11.788	***	Significant
A	<---	EOU	.310	.051	6.050	***	Significant
A	<---	SN	.062	.026	2.358	.018	Significant
I	<---	A	.501	.054	9.356	***	Significant
I	<---	U	.173	.054	3.189	.001	Significant
I	<---	EOU	.106	.046	2.328	.020	Significant
I	<---	CSE	.108	.039	2.751	.006	Significant
I	<---	SN	-.002	.024	-.089	.929	Not Significant
I	<---	EB	-.095	.063	-1.514	.130	Not Significant
AU	<---	I	.317	.101	3.152	.002	Significant
AU	<---	A	.193	.089	2.168	.030	Significant

Actual use (AU) was used to measure the frequency of use of ICT in teaching by science teachers. The proposed model hypothesized that science teachers' use of ICT was affected by two variables, attitude (A) and intention (I). The results supported the significant effect of attitude and intention on teachers' actual use of ICT and the results were: attitude ($\beta = 0.193$, $t = 2.168$, $p = 0.030$), and intention ($\beta = 0.317$, $t = 3.152$, $p = 0.002$).

5.5 Results of hypotheses examinations

This section describes the examination of the Information and Communication Technology Acceptance Model (proposed model) (see Figure 5.8 The final study model after considering the results of meditation role of EOU and U). This study examined and confirmed the reliability and validity of the proposed model. The proposed model demonstrated a good fit and all the fit indices results were supported.

Properties of the causal paths, involving explanation of variances for each relationship (β), standardized path coefficients (t-values), and p values are shown in Table 5.24. As predicted, hypothesis H5 "subjective norms significantly and directly affects external barriers" was supported in that subjective norms had a negative significant effect on external barriers, and the regression results were ($\beta = -0.059$, t =

-3.295, $p < 0.001$).Two constructs were hypothesized to be determinants of computer self-efficacy: subjective norms and external barriers. The regression results of subjective norms effect on computer self-efficacy were significant ($\beta = 0.389$, $t = 9.308$, $p < 0.001$). Based on these results, the hypothesis H6 "subjective norms significantly and directly affects computer self-efficacy" was supported. The outcomes of examining the effect of external barriers on computer self-efficacy were ($\beta = -0.038$, $t = -0.342$, $p = 0.732$). These results confirmed the insignificant effect of external barriers on computer self-efficacy. Consequently, the hypothesis H11 "external barriers significantly and directly affects computer self-efficacy" was not supported.

Three constructs were hypothesized to be determinants of ease of use: computer self-efficacy, subjective norms, and external barriers. The regression results confirmed the significant effect of computer self-efficacy on ease of use ($\beta = 0.689$, $t = 10.424$, $p < 0.001$). Based on these result, hypothesis H1 was supported in that "computer self-efficacy significantly and directly affects ease of use". The effects of subjective norms ($\beta = 0.071$, $t = 1.628$, $p = 0.104$), and external barriers ($\beta = -0.070$, $t = -0.620$, $p = 0.535$) on ease of use were not significant. Consequently, the hypotheses H7 "subjective norms significantly and directly affects ease of use" and H12 "external barriers significantly and directly affects ease of use" were not supported.

According to the suggested model, four constructs were hypothesized to be determinants of Usefulness: Computer self-efficacy, Subjective Norms, External Barriers, and Ease of Use. The regression results confirmed the effect of computer self-efficacy ($\beta = 0.205$, $t = 3.958$, $p < 0.001$), subjective norms ($\beta = 0.062$, $t = 1.934$, $p = 0.053$), and ease of use ($\beta = 0.722$, $t = 16.070$, $p < 0.001$) on usefulness. These results lead to supporting three hypotheses: H7 "Computer Self-Efficacy significantly and directly affects Usefulness", H8 "Subjective Norms significantly and directly affects Usefulness", and H9 "Ease of Use significantly and directly affects Usefulness". The outcomes of testing the impact of External Barriers on Usefulness were $\beta = -0.070$, $t = -0.842$, $p = 0.400$). These results confirmed the insignificant effect of External Barriers on Usefulness. Therefore, the hypothesis H10 "External Barriers significantly and directly affects Usefulness" was not supported.

Four constructs were hypothesized to be determinants of attitude: computer self-efficacy, usefulness, ease of use, and subjective norms. Usefulness, ease of use, and subjective norms were key determents of attitude. Based on these relationship effects, three hypotheses were formulated: H18 "usefulness significantly and directly affects attitude", H15 "ease of use significantly and directly affects attitude", and H9 "subjective norms significantly and directly affects attitude". The regression results confirmed the impact of usefulness ($\beta = 0.617$, $t = 11.788$, $p < 0.001$), ease of use ($\beta = 0.310$, $t = 6.050$, $p < 0.001$), and subjective norms ($\beta = 0.062$, $t = 2.358$, $p = 0.018$) on attitude. Therefore, all three hypotheses (H18, H15, and H9) were supported. The direct influence of computer self-efficacy on attitude was no longer available. The reason was that the arrow that showed the direct relationship between computer self-efficacy and attitude was removed, due to the outcome that computer self-efficacy affects attitude indirectly through the mediator factor ease of use. The results of testing the mediation role of ease of use between computer self-efficacy (predictor variable) and attitude (dependent variable) confirmed that the effect of computer self-efficacy on attitude is fully mediated by ease of use. Therefore the hypothesis H3 "computer self-efficacy significantly and directly affects attitude" was rejected.

Six constructs were hypothesized to be determinants of intention: attitude, usefulness, ease of use, computer self-efficacy, subjective norms, and external barriers. The regression results confirmed the effects of attitude ($\beta = 0.501$, $t = 9.356$, $p < 0.001$), usefulness ($\beta = 0.173$, $t = 0.054$, $p < 0.001$), ease of use ($\beta = 0.106$, $t = 2.328$, $p = 0.020$), and computer self-efficacy ($\beta = 0.108$, $t = 2.751$, $p = 0.006$) on intention, leading to supporting four hypotheses: H20 "attitude significantly and directly affects intention", H19 "usefulness significantly and directly affects Intention", H17 "ease of use significantly and directly affects Intention", and H14 "computer self-efficacy significantly and directly affects Intention". The outcomes of testing the impact of subjective norms ($\beta = -0.002$, $t = -0.089$, $p = 0.929$) and external barriers ($\beta = -0.095$, $t = -1.514$, $p = 0.130$) on intention confirmed the insignificant effect of subjective norms and external barriers on intention. Therefore, the hypotheses H10 "subjective norms significantly and directly affects intention" and H14 "external barriers significantly and directly affects intention" were not supported. According to the suggested model, two constructs were hypothesized to be determinants of actual use: intention and attitude. The regression results confirmed the effects of intention ($\beta = 0.317$, $t = 3.152$, $p = 0.002$) and attitude ($\beta = 0.193$, $t = 2.168$, $p = 0.030$) on actual use, leading to supporting two hypotheses: H22 "intention significantly and directly affects actual use", and H21 "attitude significantly and directly affects actual use".

Two hypotheses were formulated to test the mediation role of ease of use between the predictor variables, computer self-efficacy and subjective norms, and the dependent variable attitude. The results of examining the mediation role of ease of use highlighted that the effect of computer self-efficacy on attitude is fully mediated by ease of use. This outcome of mediation analysis supported the hypothesis H23 "The effect of computer self-efficacy on attitude is mediated by ease of use". However, the results confirmed that the effect of subjective norms on attitude is not mediated by ease of use. Accordingly the hypothesis H24 "The effect of Subjective Norms on Attitude is mediated by ease of use" was rejected.

Three hypotheses were formulated to test the mediation role of usefulness between the predictor variables, computer self-efficacy, external barriers, and subjective norms, and the dependent variable intention. The results of examining the mediation role of usefulness highlighted that the effects of computer self-efficacy, subjective norms, and external barriers are not mediated by usefulness. Accordingly the hypotheses H25 "The effect of computer self-efficacy on intention is mediated by usefulness", H26 "The effect of subjective norms on intention is mediated by usefulness", and H27 "The effect of external barriers on intention is mediated by usefulness" were rejected. Figure 5.9 show the final model with the final results. All the highlighted arrows represent the significant relationships between the variables; all green and blue dashed arrows represent the insignificant relationships; the fully mediation role of ease of use is represented by the wiggly purple arrows.

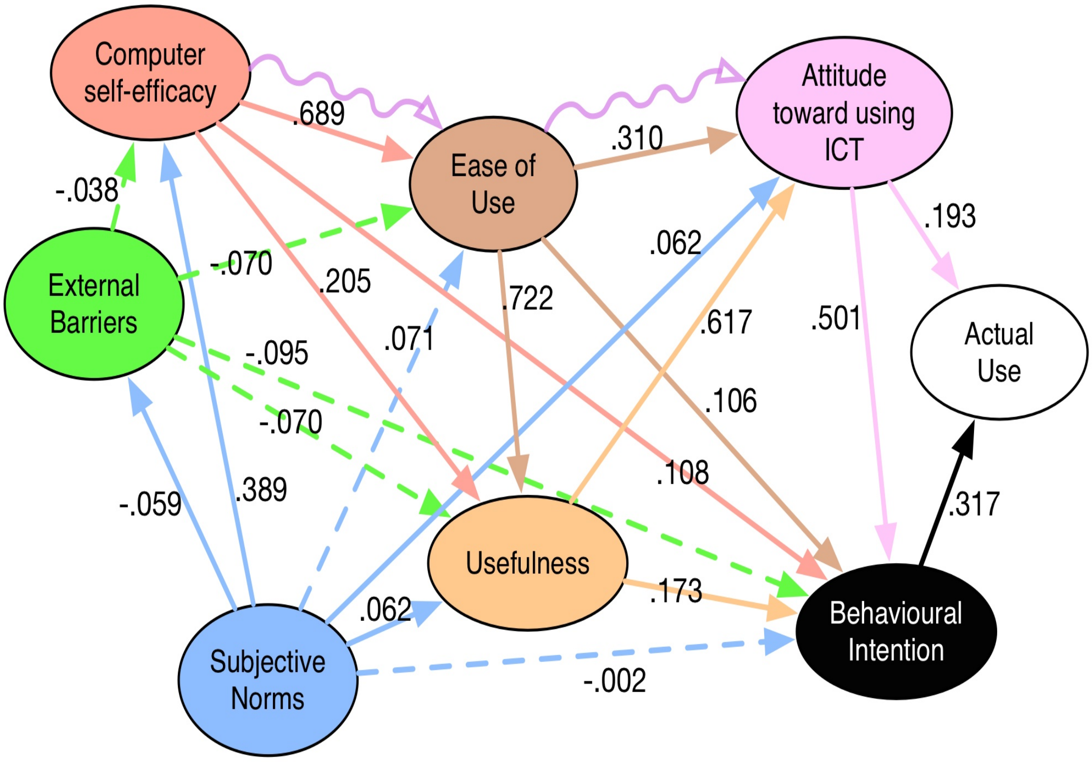
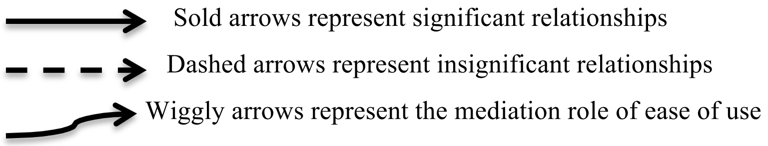


Figure 5.9: The final model representing the significant and insignificant relationships between the variables

1989, p. 985)



Chapter 6: Analysis of Science Teachers' Interview Data

The previous chapter discussed the analysis of data from the survey of science teachers' perceptions regarding their acceptance of using ICT in teaching. This chapter discusses the results of the interview data.

The purpose of using the qualitative method was to answer the questions: 1) what are the factors that prevent or encourage science teachers to use ICT in teaching? 2) To what extent do science teachers use ICT in teaching? By this is meant not just frequency of use, but also the range of different technologies and the contexts in which they are employed. These questions help in achieving a better understanding of the perceptions of science teachers about the factors that affect their use of ICT in teaching. Also they help in triangulating the results of questionnaire analysis with the findings from the interviews. The interview questions (see Appendix 3) emerged from, and are related to, the survey questionnaire described in Chapter 5.

This chapter consists of four sections. Section 6.1 provides socio-demographic information about the participants. SPSS was employed to extract the frequencies and percentages of science teachers' age, years of experience, and the availability of technical support at school. Section 6.2 provides analysis of science teachers' perceptions about the factors that prevent or encourage science teachers to use ICT in teaching. This section is divided into three sub-sections. These sections are: 6.2.1 barriers that prevent teachers from using ICT; 6.2.2 teachers' perceptions about the incentives for using ICT in teaching; and 6.2.3 teachers' perceptions about other people that are important to their use of ICT in teaching. Section 6.3 provides information about teachers' perceptions about the extent to which ICT is integrated into teaching and learning. Finally, section 6.4 briefly summarizes the findings of the interview analysis.

6.1 Socio-demographic profile of female science teachers

Twenty-one female primary science teachers were selected for interviews from the respondents of the survey questionnaire based on the selection criteria given in Chapter 4 (section 4.3). A code was prescribed for each teacher to protect their identity. They were identified as ST1, ST2, ST3, and so on.

Table 6.1 shows the ages of the interviewees. The ages ranged between 23 and 53, with the largest group of the teachers interviewed aged between 29 and 34 as shown in Figure 6.1. This indicated that they belonged to the younger age group. The distribution of interviewees showed similarity compared to the distribution of the questionnaire.

Table 6.1: Teacher age

	Frequency	Percent	Valid Percent	Cumulative Percent
23-28	5	23.8	23.8	23.8
29-34	9	42.9	42.9	66.7
35-40	3	14.3	14.3	81.0
41-46	3	14.3	14.3	95.2
47-53	1	4.8	4.8	100.0
Total	21	100.0	100.0	

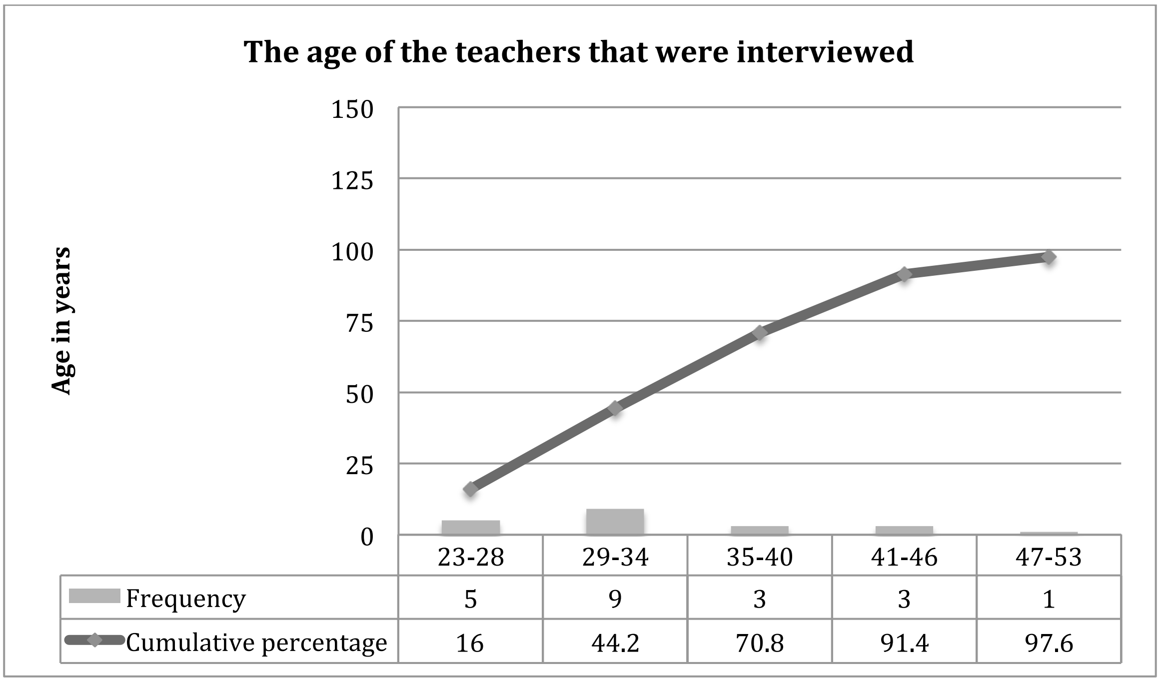


Figure 6.1: Chart of teacher age frequency

Table 6.2 shows the years of experience of the interviewed science teachers. Science teachers' years of experience ranged between 2 and 24 years, with the largest group reporting 5 to 9 years of experience (42.9%). This indicated that they belonged to the lesser years of experience group. The distribution of interviewees showed similarity compared to the distribution of the questionnaire.

Table 6.2: Years of teaching experience

	Frequency	Percent	Valid Percent	Cumulative Percent
0-4	4	19.0	19.0	19.0
5-9	9	42.9	42.9	61.9
10-14	2	9.5	9.5	71.4
15-19	5	23.8	23.8	95.2
20-24	1	4.8	4.8	100.0
Total	21	100.0	100.0	

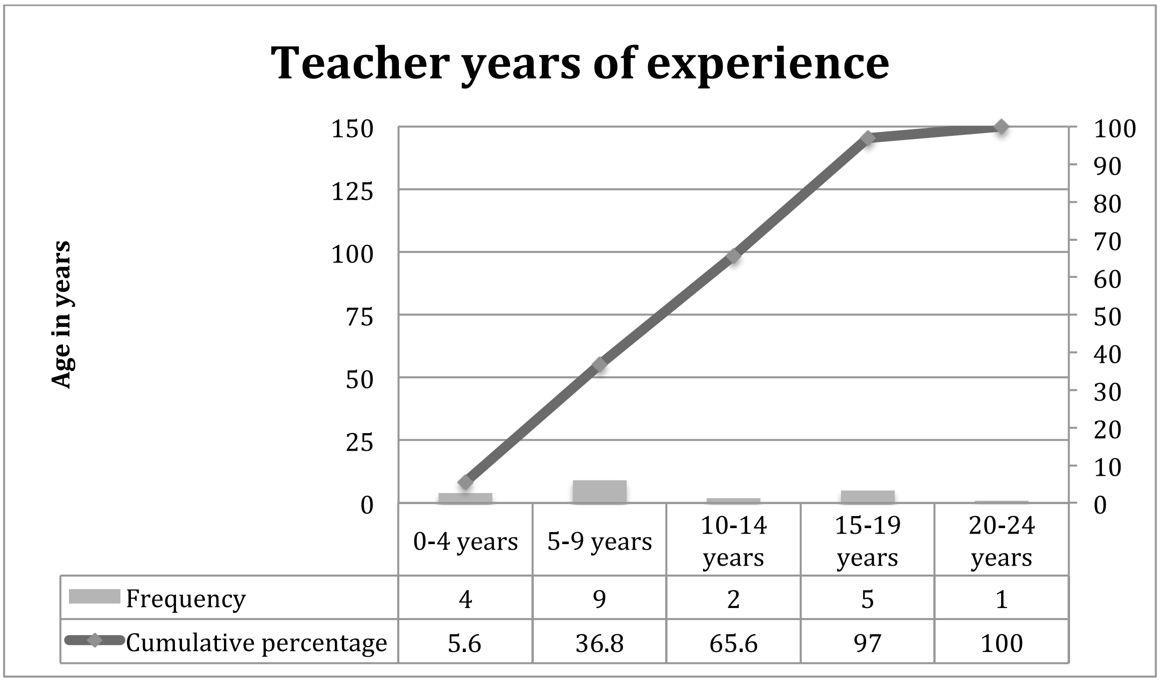


Figure 6.2: Chart of teachers' years of experience frequency

Interviewees were asked if they have laptops and Internet access at home. All respondents indicated they had laptops and Internet. Interviewees were also asked if there were computers and Internet facility in the science laboratory. All science teachers from 21 schools declared they did not have computers and Internet in the science laboratory. However, they mentioned that there were computers available in the computer laboratories in all the schools. Interviewees were then asked if the school provided technical support for ICT. Table 6.3 shows that little more than half (11 out of 21) of teachers indicated that they have technical support at school (52.4%) (See also Figure 6.3), while 10 teachers declared they did not have technical support within school (47.6%). The results indicated that a little over half of the teachers have immediate access to technical support at their schools, while the rest of the teachers rely on phone calls to call a technician.

Table 6.3: Type of access to technical support

Type of access to technical support	Frequency	Percent	Valid Percent	Cumulative Percent
Phone call (delayed)	10	47.6	47.6	47.6
Immediate access	11	52.4	52.4	100.0
Total	21	100.0	100.0	

6.2 Factors that prevent or encourage science teachers to use ICT in teaching

This section identifies some of the factors that prevent or encourage science teachers' use of ICT in teaching. It focuses on current problems regarding the use of ICT in teaching that potentially affect science teachers' perceptions and inhibit the integration of ICT in the classroom. The software NVivo was used to analyse the interviews of science teachers and answer the research questions. NVivo was applied because it facilitates systematic analysis of data for qualitative research (Ozkan, 2004; Hamrouni & Akkari, 2012; Ishak & Abu Baker, 2012). The information from the interviews was imported from the Word Processer files in which it had been transcribed to NVivo and key concepts were explored in each interview through the coding system. The data generated were studied for concepts that appeared multiple times. Similar concepts identified in different interviews were highlighted and coded and each group of codes was given a sub-node according to the issue that the concepts were highlighting. In all, eleven categories (sub-nodes) were identified from the key concepts that emerged during the interview data analysis. The sub-nodes were then clustered to form the main themes (nodes) in the research. In all, three main themes emerged from the clustering of categories representing similar issues as shown in Figure 6.3. These were: i) Barriers that prevent teachers from using ICT in teaching; ii) Incentives that encourage teachers in using ICT in teaching; and iii) other people (subjective norms) that affect teachers' use of ICT in the classroom. These nodes helped in providing a well-structured analytical framework that systemized the analysis as indicated in Figure 6.3.

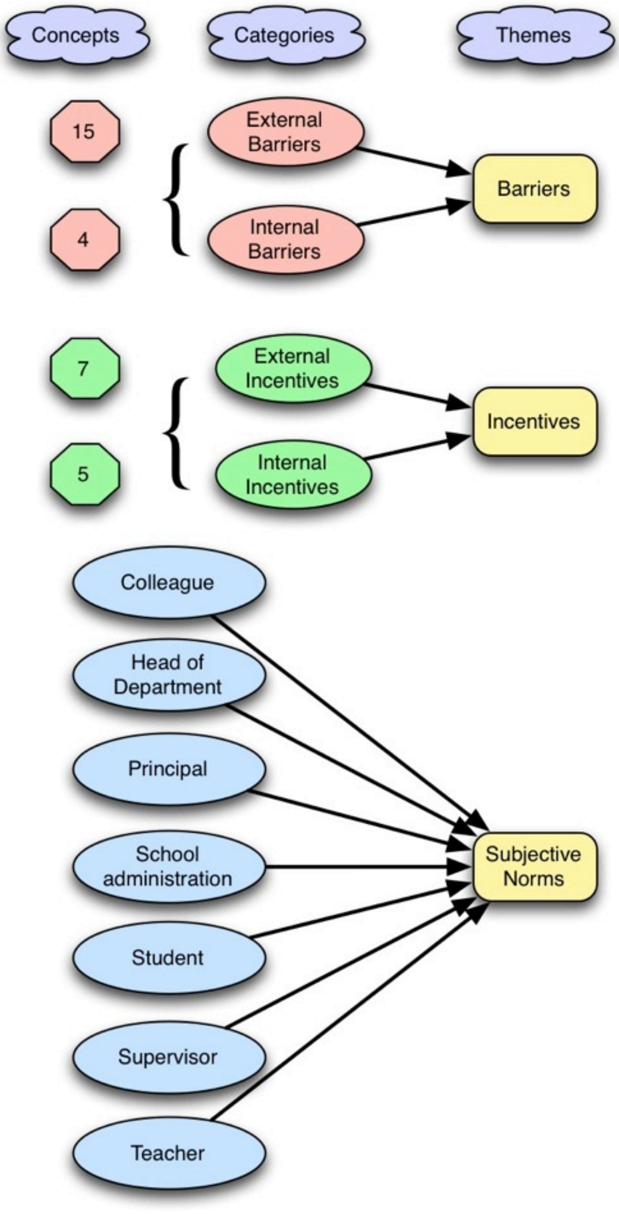
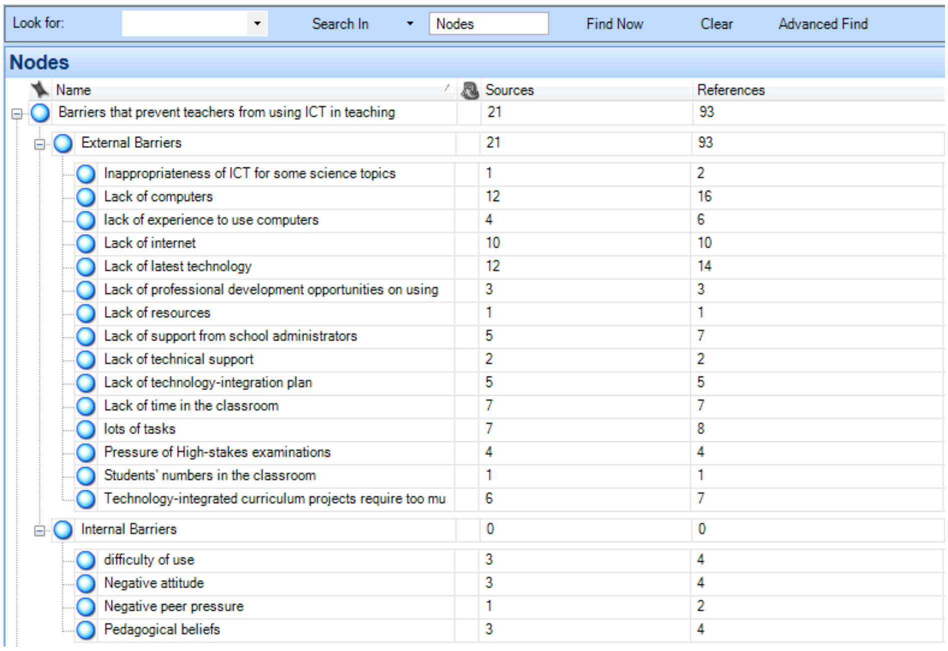


Figure 6.3: Analytical framework of factors that prevent or encourage science teachers to use ICT in teaching

6.2.1 Barriers that hinder science teachers from using ICT in teaching

Two types of barriers emerged during the interview analysis. These were: 1) external barriers; and 2) internal barriers. Figure 6.4 shows the NVivo display of the node representing the barriers that prevent teachers from using ICT in teaching, together with related sub-nodes (external barriers and internal barriers).


Look for: Search In Nodes Find Now Clear Advanced Find

Nodes

Name	Sources	References
Barriers that prevent teachers from using ICT in teaching	21	93
External Barriers	21	93
Inappropriateness of ICT for some science topics	1	2
Lack of computers	12	16
lack of experience to use computers	4	6
Lack of internet	10	10
Lack of latest technology	12	14
Lack of professional development opportunities on using	3	3
Lack of resources	1	1
Lack of support from school administrators	5	7
Lack of technical support	2	2
Lack of technology-integration plan	5	5
Lack of time in the classroom	7	7
lots of tasks	7	8
Pressure of High-stakes examinations	4	4
Students' numbers in the classroom	1	1
Technology-integrated curriculum projects require too mu	6	7
Internal Barriers	0	0
difficulty of use	3	4
Negative attitude	3	4
Negative peer pressure	1	2
Pedagogical beliefs	3	4

Figure 6.4: Node (barriers that prevent teachers from using ICT in teaching) and related sub-nodes

6.2.1.1 External Barriers

Fifteen different aspects of external barriers emerged during the interview analysis. These were: 1) inappropriateness of ICT for some science topics; 2) lack of computers; 3) lack of experience to use computers; 4) lack of internet; 5) lack of latest technology; 6) lack of professional development opportunities on using ICT in teaching; 7) lack of resources; 8) lack of support from school administrators; 9) lack of technical support; 10) lack of technology-integration plan; 11) lack of time in the classroom; 12) lots of tasks; 13) pressure of high-stakes examinations; 14) students' numbers in the classroom; 15) technology-integrated curriculum projects require too much preparation (See Figure 6.4). Each of these is explained below with examples of relevant statements from interviewees.

Similar categories were clustered together and five main themes emerged from this clustering. These themes include: 1) inadequate ability, 2) adoption of ICT, 3) uncontrollable issues in ICT use, 4) curriculum related issues, and 5) school support. Each of these themes is explained below with examples of relevant statements from interviewees.

1) Inadequate ability

The theme of inadequate ability to use ICT includes: 1) lack of experience to use computers, and 2) lack of professional development opportunities on using ICT in teaching. These barriers are explained below with examples of relevant statements from respondents.

The results of the interviews demonstrated that lack of experience to use computers was an important barrier to technology integration. Lack of experience in using technology is one of the reasons given by the respondents for not using ICT in teaching. The results revealed that lack of experience in using computers implies that the teachers lack the skills and knowledge to use some programs and also lack technology related management knowledge. As teachers remarked:

> *...I waste most of my time in preparing my lesson plan or using PowerPoint to present my lesson ....Connect the computer to the projector....I still need experience in teaching and using computer in the same time (ST19).*
>
> *...Some programs are hard to be used except Word Processer or PowerPoint, they need a lot of practice before use and English is another barrier like for example Keynote. Keynote is like PowerPoint I downloaded this application in my iPad. It is amazing, but I still learn how to use it (ST15).*

The effect of lack of experience to use computers in the classroom is not restricted to teachers but is also a consideration for students, according to one respondent regarding the barriers that affect her use of ICT in the classroom:

> *Students' unfamiliarity with the use of the computers (ST7)*

Overall, the teachers lacked experience and required additional practice with the computer before using it with their students. Unfortunately, practice time with the computer and time to familiarize the students with computers, were major determinants for implementing ICT in the classroom.

Another barrier that shows inadequate ability to use technology is lack of professional development opportunities on using ICT in teaching. The teachers need to have training courses that familiarise them with the pedagogy of using ICT, which they can draw upon when planning to use ICT in teaching science. As three teachers remarked:

> *Lack of professional development programs (ST10).*
>
> *The school does not provide professional development programs for teachers (ST11).*
>
> *Lack of computer training courses that are related to the science subject (ST19).*

The three teachers indicated that computer training and professional development were required to implement ICT that was specific for teaching science.

2) adoption of ICT

The barriers to adoption of ICT include: 1) lack of computers, 2) lack of Internet access, 3) lack of latest technology, 4) lack of resources, and 5) lack of a technology-integration plan. These barriers are explained below with examples of relevant statements from respondents.

The lack of computers is one of the barriers that limit teachers' use of ICT in the classroom. Without computers there is little opportunity for teachers to use ICT in the classroom as computers are the main devices for ICT integration in the classroom. Having computers in the classroom is important to improve the students' achievement and not providing such machines in school slows the educational process. Two teachers commented:

> *Computers are not provided in the science labs. I bring my laptop some times to use in the class but the students cannot interact with it in person because they do not have ones…Some students do not have computers at home (ST12).*

> *There are no computers in classrooms and in the science lab. If we have computers in classrooms it will save our times and students times. The focus on students learning will increase. Because students now like the technology and they use it every day at home for playing games. So, why we do not let them use it for learning also? (ST2).*

The computers that are available for teachers to use in teaching are only the ones that are located in the computer labs. These computers are obsolete and not always ready for teachers as all the teachers in the school use these computers when they need to use technology in their lessons.

> *The school's computers are old, so we need new ones (ST4).*

> *We have computers only in computer lab. But I should take students from their classes to the science lab because we need the lab to do experiment and so on. So it is difficult to take them after that to the computer lab to use the computers. Taking them from lab, I think most of the lesson time will be wasted on travelling from place to place. Especially when I know that the use of computer will not add that much on the learning of the new topic (ST17).*

In general, the lack of modern computing technology was perceived by the teachers to be a barrier to implementing ICT in their lessons.

Lack of Internet access is another barrier to ICT adoption. Using the Internet is important to search for information, for using some programs that require teachers to be online while using them, and communicating with others.

Despite all respondents having their own Internet access they declared that the unavailability of Internet access at school is an important factor that affects their use of ICT in teaching.

> *We have internet in our room, but we cannot use it to surf the Internet, we are only allowed to use it to enter our students' grades…..The Internet is important this is why we use our private Internet in the school. As I said before we use the school Internet to enter our students' grades only, but the other services are blocked (ST5).*

> *…Internet (ST10, ST13, ST14, ST 15, ST 16, ST 18, ST 3, ST 4, ST 6).*

Overall, 10 participants in the study indicated that they required greater access to the Internet in order to implement ICT more effectively with their students.

Another barrier to adoption of ICT is lack of the latest technology. The implementation of ICT in teaching requires the availability of technology. The lack of the availability of the latest technology hinders teachers from using ICT in teaching; even if teachers use their own technology they need technology to be available at school. The school should provide the latest technology by providing the proper amount and the right types of technology (such as LCD projectors, Interactive white boards, latest educational videos, and projection screen) for teachers and students so they can use them to enhance the learning and teaching process.

> *…We have the science lab which is equipped with tools like microscope, TV, DVD player, and others that we use all the time. But the lab is not equipped with computers, or LCD projector. So I use my laptop and my LCD projector, and this thing requires from me to carry my laptop and LCD projector every lesson to the science lab (ST1).*

> *It is hard to download some applications for all the students in the classroom; also some applications are not free (ST9)*

> *The school does not provide the facilities to use the computers in the classrooms (ST11)*

Respondents named some technologies that they wished to be available in the science lab and classrooms:

> *…LCD projector….(ST10, ST15, ST16, and ST17).*

> *…Interactive board….(ST5, and ST20).*

> *…Latest educational videos (ST9).*

> *…Projector screen….(ST21).*

After analysing the responses nearly half of the teachers indicated that they required greater access to the latest technology in order to more successfully integrated ICT in the science lab and classroom.

Lack of resources is another important barrier to ICT adoption that limits teachers' use of technology in teaching. Access to resources involves providing proper educational programs (such as applications, software, or curriculum programs), lessons and teaching materials that are supported by technology. The school should ideally provide these resources for teachers, as requested by ST10.

The lack of a technology-integration plan for ICT adoption in the classroom is another barrier to ICT integration. Considering the great potential of ICT for learning, a technology-integration plan should be provided by the Ministry of Education for teachers so they can understand how to use ICT in teaching.

> *Lack of technology-integration plan (ST10, ST12, ST8, and ST9).*

> *Unavailability of lesson plans previously prepared by PowerPoint (ST20).*

The comments from these five teachers indicated that they were supportive of a national curriculum with resources and materials prepared by the MoE that integrate ICT for all teachers to access and use in the classroom.

3) Uncontrollable issues in ICT use

Uncontrollable issues in ICT use include: 1) lack of time in the classroom, 2) multiplicity of tasks, and 3) student numbers in the classroom. These barriers are explained below with examples of relevant statements from respondents.

Lack of time is one of the Uncontrollable issues in ICT use that limit teachers' use of ICT in teaching. Teachers need more time to be able to use ICT in the classroom such as preparing PowerPoint slides, and selecting YouTube videos. Seven out of twenty one teachers stated there was not enough time to use ICT in the classroom. Some teachers remarked:

> *Time of the lesson is short (ST6).*

> *…Not enough time to use the computer in teaching (ST19).*

> *We do not have enough time in the classroom (ST11).*

Therefore, time management was seen as an important aspect for using ICT when teaching is restricted and accounted for during the lessons.

Multiplicity of tasks is another Uncontrollable issue that limits teachers' use of ICT in teaching. The opinions of respondents indicated that teachers are required to do additional tasks besides teaching. As teachers remarked:

> *Many additional tasks assigned to teachers (ST14).*

> *Many teaching lessons…Loads of additional administrative tasks (ST16).*

> *The extra administrative tasks that are required from the teachers like the supervision of a class and reviewing students marks of all subjects of that class; taking spare lessons when other teachers are absented; the everyday morning assembly activities which take time from teachers to be prepared because teachers need to do different activities like games, quizzes, stories, questions for teachers and students (ST17).*

> *This semester I have many classes to teach. Three teachers were on leave so we took their classes to teach them and this makes me busy all the time. They should provide teachers to teach with us…Many duties that teachers should do such as the morning assembly activities, administrative supervision, competitions, workshops, visits, and many others (ST18).*

These tasks constrain teachers from using ICT in teaching. As two teachers remarked:

> *These tasks put teachers under pressure and hinder them from using ICT in teaching (ST10).*

> *We have extra work to do; this limits our time and makes it difficult to use technology all the time (ST13).*

For these 6 teachers, ICT was an additional imposition when they were already busy and under pressure to complete additional tasks.

Student numbers in the classroom is another Uncontrollable issue that limits teachers' use of ICT in the classroom. One teacher stated that the number of students in the classroom hindered her from using ICT in the classroom:

> *Large numbers of students in the classroom. I have to concentrate on each student all the time to see if they understood which makes the use of the computer difficult because it reduces the time I spend with students (ST7).*

Although the student to teacher ratio was only mentioned by ST7, it is possible that other teachers may have felt challenged with the large numbers of students but they did not mention their class size as a barrier to using technology.

4) Curriculum related issues

Curriculum related issues include: 1) inappropriateness of ICT for some science topics, 2) pressure of high-stakes examinations, 3) extensive preparation required for technology-integrated curriculum projects. These barriers are explained below with examples of relevant statements from respondents.

Inappropriateness of ICT for some science topics is one of the curriculum related issues that limit teachers' use of ICT in teaching. An opinion of a respondent indicated that the use of technology in teaching science is inappropriate for all topics. As she said:

> *Not all the topics can be explained using technology…Sometimes I find that using the computer is difficult in the lesson, because it is hard sometimes to explain some lessons using the technology and I find it hard to transfer the information for students by using the technology, because these topics are better to be explained by tangible things specially that we are teaching in primary schools (ST9).*

Another respondent stated:

> *…In science we try always to make students explore, investigate, solve problems physically. It is important for them to see what is happening. So they can feel the problem and know how to find the solutions (ST19).*

This study also detected that the use of some educational programs to teach a new topic should be approved by the Bureau of Technical Guidance.

> *…We cannot use some educational programs without the approval of the Bureau of Technical Guidance (ST9).*

Pressure of high-stakes examinations is another curriculum related issue that prevents teachers from using ICT in the classroom. Four teachers indicated that the examinations put teachers under pressure and hindered them from using ICT in teaching:

> *Exams sometimes affect our use of technology, sometimes in the exams' period we need to make revision for the subject and answer students' questions (ST4).*

> *Pressure to cover the syllabus and focus on exams and students' results (ST19).*

> *Pressure of exams (ST8; ST14)*

The extensive preparation required for technology-integrated curriculum projects require too much preparation is also another curriculum related issue that limits teachers from using ICT in teaching.

Seven teachers mentioned the time and effort required to prepare technology-integrated curriculum projects as the barriers that hinder them from using ICT in teaching. Teachers declared they need too much time and effort to prepare the material:

> *The use of the computer in the classroom needs too much time of preparation (ST11).*
>
> *Difficulty of preparing the materials using technology (ST14).*
>
> *Planning my lessons using technology needs long time (ST6).*
>
> *Preparing the lessons' materials using technology need too much time (ST8).*

ST20 stated the need for previously prepared materials and that preparation was too time-consuming for individual teachers when resources, lesson plans, and PowerPoint presentations could be produced and shared.

Another teacher mentioned the importance of collaboration to prepare the teaching material, which would share the investment of making these resources.

> *Linking all the content of the subject with the technology needs time. We have five stages in primary if we want to use technology in all these lessons it will take time for preparing designing and presenting (ST3).*

5) School support

School support includes: 1) lack of support from school administrators; 2) lack of technical support. These barriers are explained below with examples of relevant statements from respondents.

Lack of support from school administrators was demonstrated to be one of the school support issues that may prevent teachers from using ICT in teaching. Teachers stated that the school administrators were seen as not supportive of the ICT integration. It is captured well by these remarks:

> *The school does not provide support to the use of technology (ST16).*
>
> *Unavailability of school administration support (ST18).*
>
> *…I spend too much time to prepare my lesson to teach using the computer and no motivational rewards from administration. (ST20)*

Teachers needed a shared vision and support from all departments and school administration. As one teacher mentioned:

> *…We need from all the departments of the school to help each other, exchange experiences, ideas, and solutions (ST3).*

Teachers are willing to help in providing some technology, but they also need help from the school administration in providing some technology. As one teacher stated:

...Other schools have LCD projector and Projector screen. Their principal provides for them these things, but our principal does not provide for us. You know I can buy the LCD Projector the prices are going down, but I need the screen (ST17).

In general, the teachers required support from the school administration as motivation to use ICT for teaching and learning in a collegial and supportive environment.

Lack of technical support is another school support issue that may relate to the science teachers' limited use of ICT in the classroom. Ten out of twenty one teachers indicated that they did not have technical support at school (see Table 6.3). Teachers need adequate technical support to assist them in using different technology, as is evident from the responses by ST12 and ST13.

6.2.1.2 Internal Barriers

Four different categories of internal barriers emerged during the interview analysis. These were: 1) difficulty of use; 2) negative attitude; 3) negative peer pressure; 4) pedagogical beliefs (see Figure 6.4).

Difficulty of use

Difficulty to use the computer is an important factor that may lead to constraints in using ICT in teaching. As three teachers remarked: Inability for me to walk around the class while using the computer (ST10).

...Anxiety from inability to use a program correctly (ST15).

...I find it hard to use the computer in the classroom....It takes from me long time to prepare the lesson; I do not have that experience so I prefer not to use it....While I use the computer to present I find that I am scared all the time from any fault (ST19).

Negative attitude

Only three teachers indicated negative attitudes towards the use ICT in teaching. Teachers were asked: *Do you like using ICT in the classroom, and why?* The statements of the three teachers reflected different sources of their attitudes.

A lack of support from school administration leads to a negative attitude toward using ICT for science teaching. As one teacher remarked:

No...No motivational rewards from administration (ST20).

Difficulty in using the computer and pressure from head of department are factors that lead to negative attitude toward using ICT in teaching. As one teacher remarked:

...When I use the computer in my lesson I take longer time to teach and I cannot finish or cover all the concepts of the topic, and this thing upset the head of department, because we have a fixed time to finish the syllabus (ST19).

Other aspects that impact teachers' attitudes toward using ICT in teaching are: the belief that the subject should be taught by using tangible things and experiments; the belief that using technology all the time is boring; and lack of the availability of some applications. As one teacher mentioned:

> *Yes, I like to use technology in my classroom but not always. Because the science subject mainly depends more on tangible things and experiments....The students are bored from the everyday use of technology specially that they have a lot of technology at home. It is hard to download some applications for all the students in the classroom (ST9).*

Negative peer pressure

Only one teacher indicated the negative influence of science head of department on her use of ICT in the classroom. She remarked:

> *Actually most of the time head of science department makes visits to the teachers and she assesses teachers from these visits. This makes me under pressure all the time which affects my performance because I think all the time about the assessment and I look all the time to the door expecting some body to come to watch my lesson. I feel that I'm observed all the time. This pressure makes me think all the time how to cover the topic before the time finish. This thing makes me away from using technology in the classroom because I feel that I need to finish the syllabus in fixed time (ST19).*

Pedagogical beliefs

Three science teachers indicated that the use of ICT is not always useful in teaching science due to the belief that this subject depends in its teaching on experimentation. Teachers stated:

> *…I depend more on tangible things and experiments to teach science… (ST10).*

> *…I use in my classroom materials and tools that are more important than technology and help students to understand the subject easily…And the science labs are provided by the materials and tools that are tangible. And when the students do the experiments and use the tools by themselves, they understand the lesson promptly (ST9).*

> *…I have used many different methods without using the computer to teach in attractive way, and tried always to involve students in the learning process (ST20).*

The responses of the three teachers indicated that the technology is not always important tool for enacting student-cantered activities. Thus, teachers' pedagogical beliefs play a significant role in whether or when ICT is implemented.

6.2.2 Incentives to use ICT in teaching

Two types of incentives emerged during the interview analysis. These were: 1) external incentives; and 2) internal incentives. Figure 6.5 shows the NVivo generated structure of node representing the incentives to use ICT in teaching and related sub-nodes (external incentives and internal incentives).

6.2.2.1 External incentives

Seven different factors of external incentives emerged during the interview analysis. These were: 1) availability of resources and information; 2) availability of technical support; 3) availability of technology; 4) experience in using computers; 5) fewer tasks; 6) student numbers in the classroom; and 7) support from school administrators (see Figure 6.5). After a comparison of the external incentives, the most significant influences on teacher use of ICT was the support from school administrators (with 12 resources and 12 references), which was followed by the availability of the technology) with 7 resources and 8 references).

Look for: Search In Nodes Find Now Clear Advanced Find

Nodes

Name	Sources	References
Barriers that prevent teachers from using ICT in teaching	21	93
incentives to use ICT in teaching	21	155
External Incentives	15	31
Availability of resources and information	1	3
Availability of technical support	4	4
Availability of the technology	7	8
Experience in using computers	1	1
less tasks	1	1
Students' numbers in the classroom	2	2
Support from school administrators	12	12
Internal Incentives	20	124
ease of use	5	7
Positive attitude	19	35
Positive Intention	6	9
Positive peer pressure	7	8
Usefulness	20	65

Figure 6.5: Node (incentives to use ICT in teaching) and related sub-nodes

Availability of resources and information

Teachers use the internet to find information for their lesson which is very useful. They also find educational movies that are related to the topics using YouTube. As some teachers remarked:

> *There is a lot of information online so I refer to them when needed. (ST5).*

> *In general I surf the Internet to find information about the lesson … (ST9).*

> *…I use also YouTube to display videos and educational movies. I use different websites to find information for my lessons (ST 6).*

> *I use different websites to find information for my lesson … (ST5).*

Chatting with colleagues online regarding the educational issues helps teachers in developing their approach to teaching. As one teacher stated:

> *…I used the internet to search for new information for my lessons. I have friends online, we use forums to communicate and share our plans of lessons, information, and new ideas. I can find in these forums a lot of explanations to the topics (ST7).*

Availability of technical support

Availability of technical support is an important factor that enhances the use of ICT in teaching. Teachers were asked: *Does the school provide technical support?* Table

6.3 shows eleven out of twenty one teachers have technical support at school. One respondent stated the importance of technical support and the ICT teacher in helping her when she faces any technical problems:

> *We have at school technicians. I ask them some times when I need help. They are so lovely and helpful. The computer science studies teacher also helps us. She conducts workshops for us within the school building, for example she trained us how to use PowerPoint effectively. Also, if I need to use the computer lab she prepares the room for me and turn on the computers so I save time. She is amazing (ST2).*

Another teacher declared that the time required to fix the technical problem depends on the type of the problem:

> *Yes we have technical support. If any problem happens with the computers or electricity they call the technician directly to fix the problem. And it depends how long it takes to fix the problem. Sometimes it takes minutes, but sometimes it takes days to be fixed (ST3).*

Another teacher stated that it was better to use an alternative teaching plan instead of wasting time in fixing the problem:

> *We have technical support in the school if there is any problem happens. But if the problem happened during my lesson I think it is hard to be fixed directly. You need to call the technician and then he comes to see what the problem is, all that takes time. So I prefer to continue my lesson without calling the technician and use alternative plan (ST5).*

Another teacher in a school that did not have a local technician stated that a technician can come and fix the problem after calling him:

> *No I think there is no technical support at school. But I think we can call them so they come to fix any problem (ST13).*

Availability of technology

The availability of technology is an important factor for teachers to use ICT. The use of ICT requires having technologies that allow for teachers to practise teaching with these technologies. Respondents try to overcome the lack of technology in the school by using their own technologies. All teachers stated they have laptops, smart phones, and Internet which are the main requirements to use ICT in teaching. Most of them, if not all, used these technologies in the classroom. As teachers remarked:

> *The lab is not equipped with computers, or LCD projector. So I use my laptop and my LCD projector (ST1).*

> *I use my laptop or my iPad. I like iPad more because it is easy to carry and I can connect it to the projector so I can display my lesson on Keynote, it is like PowerPoint. I connect to the internet and use YouTube movies because I have wireless. I provide the internet, iPad, and laptop. The science lap is supplied by LCD projector, and the projector screen. I cannot imagine one day without using these technologies. Sometimes I ask students to bring their computers or their*

iPads. So they can play educational games, watch educational movies, or to show them some of the educational websites that can help them in studying science (ST3)

Teachers also stated that the school should provide technology to enhance their use of ICT in the classroom. Provide the most modern technologies in classrooms (ST7).

The availability of computers for students helps them in applying what they learned by playing educational games, or watching educational videos (ST21).

The availability of computers and Interactive boards (ST20).

Availability of Internet, computers and LCD projector (ST14).

Keep up the latest innovations (ST12).

Experience in using computers

The effect of experience and familiarity with using computers is not restricted to teachers only. Students' prior experience also influences teachers' capacity to enhance the integration of ICT in teaching as stated by one respondent when she was asked about the incentives to use ICT in teaching.

Students' familiarity with the use of the computers (ST7).

The experience and competence in using ICT positively affects teachers' perceived ease of use of ICT in teaching. As one teacher remarked:

…With practice and learn it will be easy to use it in the classroom (ST8).

Fewer tasks

It is important to make sure that teachers spend the time in teaching students, learning how to use new tools in teaching, and preparing materials for lessons. Thus, it is important to reduce the number of additional tasks that are required from teachers to enhance the use of ICT in teaching. As one teacher remarked:

Reduce the amount of work that is required from teachers (ST1)

Students' numbers in the classroom

Reducing the number of students in the classroom is another important factor that may help in promoting the use of ICT in the classroom. Two respondents remarked:

Reduce the number of the students in the classroom (ST12, ST7).

Support from school administrators

Respondents indicated that the principal, head of department or supervisor provide support for the use of ICT in teaching. This support gives the teachers the motivation to use the ICT in teaching, especially when the use of ICT is involved within the annual assessment report of teachers' performance. Therefore, it is understandable that the support from the school administrators was the most significant external incentive for a teacher to use ICT in their teaching.

The visits and comments by the head of department and principal are important factors that increase the teachers' use of ICT in teaching. As remarked by one teacher:

> *The principal or the head of science department or the supervisor observe everything you use in the classroom. And after the lesson when I go to them to give me the feedback, they mention my use of PowerPoint or other tools, and they encourage me to continue use the technology. So I think they take it into account which is good (ST4).*

Teachers' concerns about their results on the assessment report that is marked by the principal, head of department, and supervisor lead to improvement in the teaching process. As stated by one teacher:

> *Using different tools to support teaching are important for our assessment and we should use in all our classes tangible things but not necessarily the computer. Our science labs are supplied with different tools and technologies that are useful for our lessons (ST14).*

The principal's care of teachers' needs leads to using ICT in teaching. As one teacher remarked:

> *…There are no computers in the science lab and we told the principal to talk to the ministry. And the principal is trying intensively with the ministry to provide computers in science labs (ST 1).*

The good relationship and trust between teachers and principal, head of department, and supervisor encourages teachers to think positively about the use of ICT in the classroom. As remarked by these four teachers:

> *…The principal encourages the use of tangible tools, and also recommends the use of technology in the classroom as much as possible (ST13).*

> *The principal, the head of science department and the supervisor advise and encourage us to use technology in our lessons (ST3).*

> *The principal and the head of department encourage me to use the computer (ST5).*

> *The principal, the head of science department or the supervisor express concern about using technology in the classroom (ST6).*

A teacher declared that the use of ICT in teaching depends on her discretion and it is not mandated, but the principal always encouraged her to use it in teaching:

> *Actually the principal and head of department encourage us to use the computer in teaching, but they do not force us (ST10).*

Other teachers when they were asked, *What are the incentives to use ICT in teaching?* stated that the acknowledgment and reward from the school administrators are important factors that encourage teachers to use ICT in teaching:

> *Availability of support from school administrators (ST2).*

Rewards from the school administration (ST19).

6.2.2.2 Internal Incentives

Five different categories of internal incentives emerged during the interview analysis. These were: 1) ease of use; 2) positive attitude; 3) positive intention; 4) positive peer pressure; and 5) usefulness (see Figure 6.5). The most significant internal incentive for using ICT was perceived usefulness of the technology, which was indicated by 20 out of 21 teachers with 65 references.

Ease of use

The ease of using ICT in teaching is an important factor that affects teachers' use of ICT in the classroom. Three teachers mentioned the ease of using ICT in teaching. As teachers remarked:

> *…For me, using technology in the classroom is not hard, specially that using it promotes the students' academic achievement (ST3).*

> *I like using the technology in my class. I can find all the information that I need very quickly… The computer is easy to use and facilitate my task of teaching (ST 5).*

> *Ease to deliver information for students, especially if there are no tangible things that I can use to explain the lesson. Sometimes I find it easy to use the computer in the classroom… (ST9)*

Also, when teachers were asked about the incentives to use ICT in teaching, two teachers stated:

> *Ease of use by teachers and students, because they possess computers… It is easy to use and it is useful for students. They can understand the lesson easily. I and students feel excited during the lesson (ST10).*

> *Easy to use (ST 7).*

In addition, 19 out of 21 teachers agreed that a positive attitude provided an internal incentive to use ICT for teaching and learning in their classroom.

Positive attitude

Nineteen out of twenty one teachers indicated that they have a positive attitude toward using ICT in teaching when they were asked: *Do you like using ICT in the classroom, and why?*

The perceived usefulness of ICT in the classroom affected teachers' attitudes, because it helps them to explain the content and it engages the students. Pertinent statements included:

> *Sure I like. Students understand the topics easily. I present the lesson by PowerPoint which makes it easy for me to organize my ideas about the topic (ST1).*

> *Yes, I like to use the technology in my lessons because it attracts students' attention, and helps me a lot in explaining most of the topics (ST 11).*

Yes I like it, using technology clarifies the ideas and eases providing the advanced scientific research. Using technology provides scientific information in excellent way (ST12).

Yes I like it so much; I can use it to explain my lessons because it simplifies information and students like it (ST13).

Yes, I like to use it when it is needed because it helps students to understand and enjoy their time without feeling bored (ST 14).

Yes, using technology in the classroom is useful for students; it draws their attention and makes learning interesting (ST 15).

Yes, it helps in explaining the lesson in attractive way, and helps students to understand the lesson easily (ST16).

The opinions and encouragement of the principal and head of department are important and affect the attitudes of teachers toward using ICT in the classroom. One pertinent comment was made that the use of ICT promotes a positive attitude towards using the computer.

I like it because it is interesting and useful for me and student. Also the principal and head of department care about my use of computer and I am happy for that (ST17).

The ease of using ICT in the classroom affects teachers' attitudes toward using ICT in teaching, because it makes the teaching and learning process easier:

Yes, I like to teach using the computer. It is easy to use and it is useful for students. They can understand the lesson easily. I and students feel excited during the lesson (ST 10).

The usefulness of ICT in the classroom positively affects students' attitudes and encourages them to feel excited about learning. The teachers stated that the computer made the lesson more engaging because the lesson material was presented in a more attractive format:

…The speed in transferring information for students in attractive and exciting way (ST8).

Provide attraction and excitement to the lesson (ST15).

Facilitate teacher's work… It helps students to understand and enjoy their time without feeling bored (ST14).

Positive intention

Behavioural intention is an important factor that affects teachers' use of ICT as noted by six respondents.

Teachers who have average use of ICT indicated that they intend to use ICT regularly in future. As teachers remarked:

I do not use it every day, but I would like to do… (ST13).

…I will try to use it in my classroom as much as possible… (ST 14).

Teachers' ICT competency and the ease of use of ICT in teaching affect teachers' intention to use ICT in teaching. As one teacher remarked:

…With practice and learn it will be easy to use it in the classroom…I would like to use it more…I am thinking to use it more in future… I do not use the Instagram to post educational subjects. I would like to use it in future and I would like to add parents to my page in Instagram so they can ask me questions related to their children (ST8).

Teachers who did not use the computer for the last six months of semester two indicated also that once the school provides technology they will use it.

… If they provide all the facilities that help me in using technology in the classroom… (ST18).

… I wish that they provide LCD projector in the science lab so I can use it as much as I want… (ST21).

One teacher who uses the computer frequently in teaching indicated that she will use Instagram and WhatsApp in education. As she remarked:

Instagram and WhatsApp I used them for private purposes. But it is good idea to use them in education (ST3).

Positive peer pressure

Seven teachers indicated that the principal, head of department, or supervisor encourage them to use ICT in teaching and these acknowledgements help in increasing the use of ICT in the classroom.

Teachers are not obliged to use ICT in teaching, so they decide to use or not to use ICT in teaching. As teachers remarked:

Actually the principal and head of department encourage us to use the computer in teaching, but they do not force us (ST 10).

I am free to use or not to use computer in my teaching (ST 5).

However, the acknowledgements of the principal, head of department, or supervisor play an important role in motivating teachers to use ICT in the classroom. As remarked by teachers:

Honestly the principal and head of department's opinions are important for me (ST11).

The principal or the head of science department or the supervisor observe everything you use in the classroom....So I think they take it into account which is good (ST 4).

The principal, the head of science department or the supervisor concern about using technology in the classroom. I can see their feeling when they attend my class *and find that I am using PowerPoint or YouTube or any other technology. They give me a lot of supporting comments that are really important for me (ST6).*

The use of ICT in teaching is not the target for the principal, head of department, or supervisor. They focus on the lesson itself and how the teacher is able to explain and clarify the lesson for students by using different methods and tools. As teachers remarked:

Actually the principal or the head of science department focus more in the approach that I use in teaching science. But using the computer in the classroom make them feel that you are working hard to make the lesson attractive (ST7).

We should use all the tools that can help us in providing a good lesson that enhances student achievement and impress the principal, the head of science department, or the supervisor (ST8).

Perceived usefulness

Twenty out of twenty one teachers indicated the usefulness of ICT in teaching. Thus, this was the most significant internal incentive to use ICT in the classroom. The perceived usefulness of ICT was evident because the teachers used technology to help their teaching, to explain concepts simply and easily, and to save time and effort.

Teachers indicated that ICT is important for clarifying and simplifying the information for students. As remarked by teachers:

Helps to transfer the information quickly… Using technology to teach science is better than teaching by using traditional way (ST10)

There are some lessons that should be explained by using videos… Using technology helps in not to be restricted with the text book … Clarifies the ideas and eases providing the advanced scientific research… provides scientific information in excellent way (ST12).

Speed in finishing the lesson and simplifying the information… Transfer information easily and draws students' attention… I can use it to explain my lessons because it simplifies information (ST13).

....Simplify some of the concepts that are hard to be explained theoretically....Facilitate for students understanding, and for teachers explaining (ST14).

Helping teacher to transfer the information… Simplify information for students. Confirm information for student so they can understand it and remember it in the exam… It helps in explaining the lesson in attractive way, and helps students to understand the lesson easily (ST16).

Using technology clarifies the information for students in sequential way, and indicates how much the teacher is knowledgeable....Entrenches student information in a better way.... Helps teachers in teaching (ST18).

… Clarify the information for students (ST2).

....Helps to transfer the information easily for students.... Simplify the information for students (ST 7).

....Provide sequence in ideas and organize them during the explanation of a new topic in the classroom (ST8).

Easy to deliver information for students, especially if there are no tangible things that I can use to explain the lesson... Using technology in the classroom saves my time and effort (ST9).

Also, teachers indicated that ICT is important to enhance student achievement because it enables the students to absorb the concepts more easily. As teachers stated:

....It is easy to use and it is useful for students. They can understand the lesson easily. I and students feel excited during the lesson (ST10).

Technology attracts students to the lesson... Facilitate the explanation of many topics... Student response and understanding of lessons....It attracts student attention, and helps me a lot in explaining most of the topics (ST11).

Promotes students' performance (ST17).

... draws student intention (ST18).

Students understand the lesson in attractive and interesting way (ST19).

It helps the student to remember the answer in the exam... Facilitate the teaching and learning process... helps them in applying what they learned by playing educational games, or watching educational videos... Using the computer in displaying the lesson gives life to lesson; takes away the boredom from the classroom; and activates students (ST21).

Students become active in the classroom... It helps to deliver the information for students easily. It brings a fun atmosphere to the lesson... it promotes the students' academic achievement (ST 3).

...Noticeable response from students indicates the benefits from using computers in the classroom (ST4).

Enhance the student academic achievement... I can use it to coordinate and offer a better lesson... facilitate my task of teaching... for students it makes it easy for them to absorb the lesson (ST5).

Students accept the subject. Students become active and respond with the lesson positively (ST6).

The ease of delivering the information for students through the use of the computer in the classroom (ST8).

Students understand the topics easily (ST 1).

Moreover, teachers indicated that a benefit of ICT enabled them to find the information more easily for teaching. As teachers remarked:

> *....There is a lot of information on the website that can help me in teaching. I can use YouTube for example to display some experiments (ST18).*

> *....Useful for teaching science because there are many educational videos that can be used in teaching (ST19).*

> *It provides us with information and latest educational videos (ST7).*

In addition, the use of ICT enhances the teaching performance and productivity of teachers. As teachers remarked:

> *... It affects positively my assessment report results (ST3).*

> *... It facilitates my work in the classroom...It improves my teaching performance (ST6).*

Furthermore, teachers indicated that the use of ICT in teaching is beneficial for saving time and effort during the lesson and for preparing the lesson materials, as stated by ST4 and ST7.

The ease of using ICT to find information positively affects the perceived usefulness to use ICT in the classroom. As remarked by teachers:

> *Ease of reaching the information specially from English resources because they are more developed and interesting. Organize my ideas. Speed in access information (ST15).*

All the previous opinions of the teachers regarding the usefulness of using ICT in teaching indicated that the use of ICT in teaching is beneficial for clarifying the information, drawing students' attention, finding information, and saving time and effort.

6.2.3 Other people who affect teachers' use of ICT (subjective norms)

Seven people who are important to teachers for using ICT in teaching emerged during the interview analysis. Those people were: 1) colleagues; 2) head of department; 3) principal; 4) school administration; 5) students; 6) supervisor; and 7) teacher (self) (see Figure 6.3).

Table 6.5 shows the other people which science teachers indicated are important for them and affect their use of ICT in teaching. The majority of teachers, 18 out of 21 (85.7%), indicated that students were important for them and affect their use of ICT in teaching. Eight out of twenty one teachers (38%) indicated that the principal is an important person for them and her opinion regarding the use of ICT in teaching is taken into account by them. Six teachers (28.5%) indicated that head of department affects their use of ICT in teaching. Five teachers (23.8%) indicated that they themselves affect the use of ICT in teaching, because if they like to use ICT, then nobody can stop them; and if they do not like to use ICT, then nobody can force them to use it. Four teachers (19%) indicated that the supervisor affects their use of ICT in teaching. Three teachers (14.2%) indicated that their colleagues affect their use of ICT in teaching. Finally, two teachers (9.5%) indicated that school administration affects their use of ICT in teaching.

Nodes

Name	Sources	References
Other people affect teachrs' use of ICT (subjective norms)	21	46
Students	18	18
Principal	8	8
Teacher	5	5
Colleague	3	3
Supervisor	4	4
Head of Department	6	6
School administration	2	2

Figure 6.6: Node (Other people who affect teachers' use of ICT) and related sub-nodes

6.3 Use of ICT

This section discusses the actual use of ICT by the science teachers. It focuses on the level of use of ICT and types of technologies that were used inside and outside the classroom. NVivo was used also to analyse the interviews of science teachers to answer the research question regarding the use of ICT. Key concepts were explored in each interview, highlighted, coded, and then clustered. Then each cluster was assigned to a theme, which was then classified under a broad category. Two categories (sub-nodes) were identified from the key concepts that emerged during the interview data analysis. The sub-nodes were then clustered to form the main theme (node) in the research. One main theme emerged from the clustering of categories representing similar issues as shown in Figure 6.7. This was the use of ICT. This node helped in providing a well-structured analytical framework that systemized the analysis as indicated in Figure 6.7.

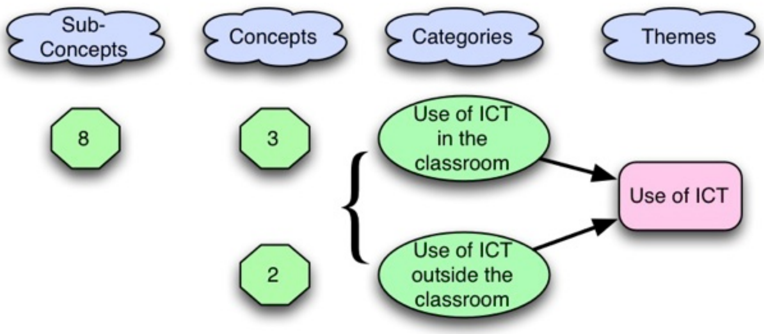
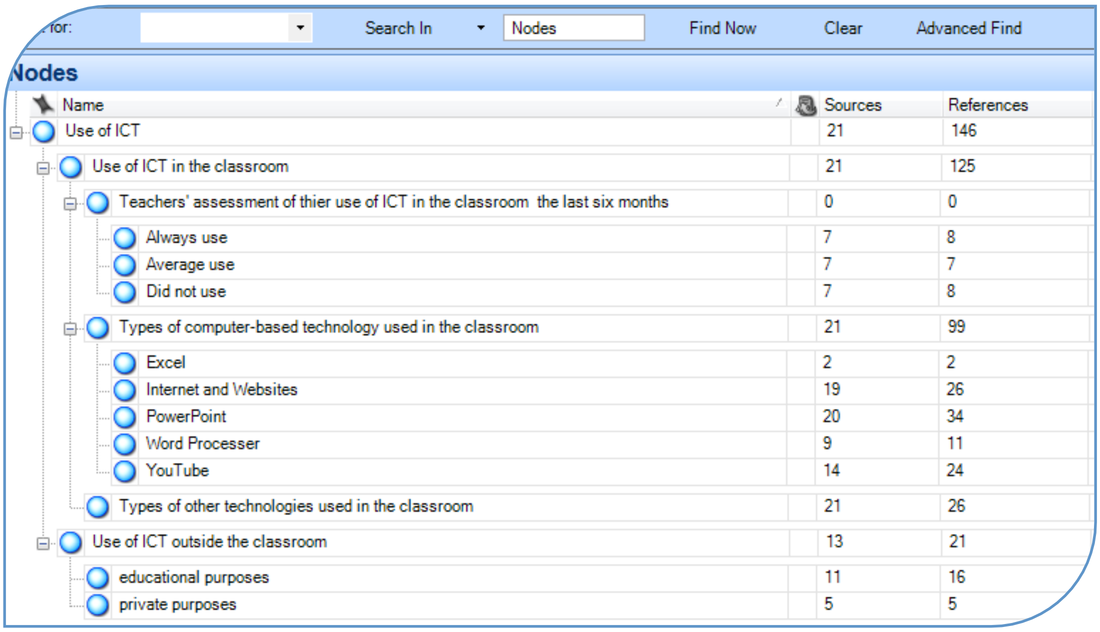


Figure 6.7: Analytical framework for the use of ICT



Name	Sources	References
Use of ICT	21	146
Use of ICT in the classroom	21	125
Teachers' assessment of thier use of ICT in the classroom the last six months	0	0
Always use	7	8
Average use	7	7
Did not use	7	8
Types of computer-based technology used in the classroom	21	99
Excel	2	2
Internet and Websites	19	26
PowerPoint	20	34
Word Processer	9	11
YouTube	14	24
Types of other technologies used in the classroom	21	26
Use of ICT outside the classroom	13	21
educational purposes	11	16
private purposes	5	5

Figure 6.8: Node (use of ICT) and related sub-nodes

Two kinds of ICT use emerged during the interview analysis. These were: 1) use of ICT in the classroom; and 2) use of ICT outside the classroom (see Figure 6.8).

6.3.1 Use of ICT in the classroom

Three categories regarding the use of ICT in the classroom emerged from the analysis of the interviews. These were: 1) teachers' assessment of their use of ICT in the classroom during the previous six months; 2) types of computer-based technologies used in the classroom; and 3) types of other technologies used in the classroom (see Figure 6.8).

6.3.1.1 Teachers' assessment of their use of ICT in the classroom the last six months

There were three types of frequency regarding the level of ICT use in the classroom the last six months. These were: 1) teachers who always use ICT; 2) teachers with average use; and 3) teachers who did not use ICT (see Figure 6.8).

Teachers who always use ICT

Teachers were asked: *How do you assess your use of ICT in teaching the last six months?* The comments from these teachers indicated that they used ICT to present using PowerPoint, show YouTube videos, discuss educational issues (such as Instagram, WhatsApp, online forums, search websites for lesson content), and to create documents (such as worksheets, tests, and activities).Seven teachers (ST1-ST7) indicated that they always used ICT in the classroom. As teachers remarked:

> *I have two classes. I teach each class 3 days per week. I use the computer in all my lessons to present the lessons using the PowerPoint. I use the computer to present a video if the topic needs that. For example I used YouTube to show the students the volcano because we cannot use the experiment to see the volcano. So it depends on the lesson some lessons need to be explained by experiments. Because we teach science so students are taught by using experiments. We have the science lab which is equipped with tools like microscope, TV, DVD player, and others that we use all*

the time. But the lab is not equipped with computers, or LCD projector. So I use my laptop and my LCD projector, and this thing requires from me to carry my laptop and LCD projector every lesson to the science lab. The science department has account on Instagram. We post some pictures, information about exams and parents can follow us on Instagram. So they can track the new improvements and they can ask questions about the subject. Science teachers have group on WhatsApp. We share links, information about science, discuss some educational issues (ST1).

It has been used approximately every day. I use it to clarify the information for students. I write the lessons plans using the word processer and the PowerPoint. I search the Internet to find information for my lessons. There are many online forums, in these forums they discuss new teaching ideas, and they provide lesson plans and Power Points for science lessons. And on YouTube there are many science lessons that I refer to when I plan some of my lessons. I have Instagram, whatsApp in my phone. Our school has account on Instagram which they use it to upload school's news, time of exams, and time of parents-teachers interviews. Our department has a group on WhatsApp that we use to discuss the new educational issues. My department has WhatsApp, we use it to communicate and share ideas (ST2).

I am glad from my use. I think I used all the tools in all my lessons to teach students in attractive way. I used the PowerPoint in all my lessons to display the lessons. I used the Word Processer to write the lessons' plans, tests, worksheets, activities. I used YouTube to display some programs and movies. I used websites to find information. But Instagram and WhatsApp I used them for private purposes. But it is good idea to use them in education. So I can communicate with parents and colleagues, or to post some videos and pictures that are related to my lessons (ST3).

I am happy with my use so, so, so much, because I like to use any new innovation in technology. I used the computer and other technologies every day in my lessons (ST4).

Every day, I cannot teach without it. I use PowerPoint to display my lessons, find information on Internet, and download and watch YouTube educational videos. The school has account on Instagram and the science department has an account on Instagram. We use them to post every new issue in our school. Also all teachers in the school have blogs so they can upload new questions for the students and communicate with parents (ST5).

I use the computer most of the time in my lessons I used the PowerPoint most of the time for displaying the lesson. I used the computer to display students' projects. I used it for finding information, and displaying YouTube videos. I have Instagram but I do not use it to post educational issues. I use WhatsApp to communicate with science teachers and we use it to send information about science which I find it useful (ST6).

Excellent, I am satisfied with my use of the computer in the classroom. I used the PowerPoint to present my lesson in interactive way. I used the internet to search for *new information for my lessons. I have friends online, we use forums to communicate and share our plans of lessons, information, and new ideas. I can find in these forums a lot of explanations to the topics. There is an account on the Instagram for school generally, and for science department specially. We use them to post activities and pictures, and any other things that benefit teachers, students, and parents (ST7).*

Teachers with average use

Teachers were asked: *How do you assess your use of ICT in teaching the last six months?* Seven teachers (ST8-ST14) indicated that they had average use of ICT in the classroom. As teachers remarked:

> *I use from time to time educational games that provide learning in motivating way. I use PowerPoint to display some lesson. I use sometimes YouTube to display videos. I use Instagram to post subjects or pictures that are related to the subject and receive comments from parents or even students. I use WhatsApp to discuss with teachers new ideas that are related to the subject (ST9).*

> *I used technology in some of my classroom lessons. I depend more on tangible things and experiments to teach science. I used the computer depending on the lesson if it needs computer or not. I used the PowerPoint and YouTube in my lessons (ST10).*

> *I use technology in my classroom to present the PowerPoint presentations, to display movies which we need in explaining some topics in science that cannot be demonstrated or explained by experiment in the classroom, or to find information about new ideas for my lessons using the Internet (ST12).*

Some comments of some respondents indicated that they intend to increase their ICT usage in the future. As teachers remarked:

> *50%. I am satisfied with my use at this stage. But what I really would like from the school and the ministry of education to provide all the facilities that help us to increase our use of technology in our lessons. I used the Internet to search Google finding information for my lesson from different forums and websites. I used PowerPoint in my lessons and I used YouTube. The school has account on Instagram so all teachers can post any new ideas or photos related to the subject that they teach. And most of the parents are following us on Instagram. I like Instagram because it is useful and easy to use. The science department has group on WhatsApp so we can use it to share ideas and to communicate with each other (ST11).*

> *I do not use it every day, but I would like to do. My use depends on the lesson so I use videos some times because there are a lot of educational video that are useful, I use PowerPoint some times to display the lesson specially if the topic was hard and needs from students to pay more attention. WhatsApp and Instagram are applications in my phone. The science department has account on Instagram to post information for parents. Our department has group on WhatsApp we use it to send video and audio broadcasts or pictures; or to communicate (ST13).*

Honestly, I am not satisfied with my use. I teach three lessons each week for each class and I have three classes, so I use it at two lessons per week. But I will try to use it in my classroom as much as possible. I like to use the PowerPoint for presentation, YouTube for educational videos, and online forums to find new ideas (ST14).

Teachers also indicated that the intention to increase the ICT usage in the future was due to the usefulness of using ICT in teaching. As one teacher remarked:

I do not use it all the time in the classroom. But I use it in some of my lessons. For example I use the PowerPoint, TV, and YouTube if I feel that the lesson needs to be explained by using the computer. I would like to use it more, but I do not have the time to prepare the material using the technology. But I am thinking to use it more in future, because it is really useful for me and for students. I have Instagram and WhatsApp. Actually I use WhatsApp to communicate with teachers and with the head of science department to discuss subjects that are related to the teaching. But I do not use the Instagram to post educational subjects. I would like to use it in future and I would like to add parents to my page in Instagram so they can ask me questions related to their children (ST8).

Overall, the teachers that had an average use of ICT could see the benefit of using technology in the classroom and were likely to increase the implementation of ICT in the future.

Teachers who did not use ICT

Teachers were asked: *How do you assess your use of ICT in teaching the last six months?* Seven teachers (ST15-ST21) indicated that they did not use ICT in the classroom. In general, the reasons that the teachers provided for not using ICT in their teaching were based on a lack of time, lack of resources, difficulty with obtaining and using computers. Some teachers were disappointed and regretted that they did not integrate ICT into their lessons for these reasons. However, one teacher was concerned that ICT was not adequately recognized because it was not reflected or acknowledged in the reports.

The additional tasks that were assigned to teachers prevented them from using ICT in the classroom. As one teacher remarked:

I did not use technology the last six months because I was busy preparing for my workshop and the typical lesson that I conducted last week, It took from me long time because the workshop was about explaining all lessons for grade two of science text book with the materials and tools, so it was not easy. In the day of the workshop I have distributed booklets related to the science subject and simple souvenirs that I decorated by myself for all the audiences. All the audience were impressed of what I did. But in semester one I used technology not always but as needed. And next year I will try to use it more (ST15).

Teachers indicated the use of ICT is not important to make the lesson attractive; using many different methods in teaching can also add fun and attraction to the lesson. As one teacher mentioned:

> *Honestly, I did not use it in teaching, but I used it to write the exams. I like using the computer in teaching, but I think that I am good teacher and I use all my experience in teaching and trying always to involve students in the learning process by using experiments and tangible things to transfer information for students… Our department has account on Instagram so we can share new ideas and communicate with parents (ST16).*

Lack of computers was an important factor that hindered teachers from using ICT in teaching, as is evident from these remarks made by science teachers:

> *This semester I did not use it because the science lab lacks the computers, Internet, LCD projector, and Projector screen. And I have tools in science lab help me in explaining the lessons and doing experiments… I have Instagram and WhatsApp I use them for my personal use (ST17).*

> *I use the PowerPoint, the word Processer, YouTube, and websites. Actually I do not use computer in teaching all the time, I use the science labs' tools. But I do not use them always; it depends on the lesson and how much it will help me in my lesson…This semester, no I did not use it. I was busy all the time I had many classes to teach, I had many tasks to do. These things distracted me from using the computer in my lessons, because preparing my lesson using the computer takes long time and I really do not have time (ST18).*

> *I did not use the computer in my teaching the last six months. I find it hard to use the computer in the classroom. It takes very long time to prepare the lesson plan, and to teaching using the computer. It exhausts me (ST19).*

> *I did not use it during this period. I found that using the computer needs from me effort and time for preparation. I have to focus on syllabus and exams, because I do really care about students' academic achievement. So I tried always to use teaching methods that take less time in preparation. I used the computer in my teaching before, but I found that nobody motivates me to use the computer in the classroom. I was shocked from my last year report's result. Despite the ample use of the computer in my lessons and participation in the school's activities, my result was not satisfactory (ST20).*

> *Regrettably, I did not use the computer this semester, the computer lab was busy all the time and it was hard to find a day to use the lab. I wish that they provide LCD projector in the science lab so I can use it as much as I want. Our department has group on WhatsApp, it is interesting I really like it, and we chat, send broadcasts, and share different ideas. I downloaded Instagram recently, but my department does not have account on Instagram and I do not use it for educational purposes (ST21).*

6.3.1.2 Types of computer-based technology used in the classroom

The major ICT programs that were used by science teachers in the classroom emerged from the analysis of the interviews. These were: 1) Excel; 2) internet and websites; 3) PowerPoint; 4) word processer; 5) and YouTube (see Figure 6.8). All the teachers used presentation software/with slides, nearly all the teachers used the

Internet and websites (19/21), and 14 teachers specifically named YouTube for a source of educational videos. Word processing is relatively common and used by nearly half of the teachers (9/21), but only 2 teachers indicated that they used Excel as part of the teaching.

Excel

Generally teachers used Excel to enter students' grades because only 2 teachersindicated that they used tables or spreadsheets as part of their teaching. As a teacher remarked:

> *I use Excel to enter the students' grades (ST2).*

Internet and Websites

Teachers indicated that they used Internet and different website to find information for the lesson, share ideas with others, and download educational videos. As teachers stated:

> *I used the Internet to search Google finding information for my lesson from different forums and websites (ST11).*
>
> *I use the Internet; it helps me finding information. The internet is really useful you can find most of the things that you are looking for. (ST12).*
>
> *…Online forums to find new ideas (ST14)*
>
> *…I search the Internet to find information (ST18).*
>
> *I download the educational videos from the Internet if I cannot use the experiment in my lesson (ST21).*

One teacher indicated that she used online forums to communicate with friends and share ideas. As she remarked:

> *…I used the internet to search for new information for my lessons. I have friends online, we use forums to communicate and share our plans of lessons, information, and new ideas. I can find in these forums a lot of explanations to the topics… (ST7).*

Another teacher indicated that she uses the internet to help students play educational games. As she declared:

> *In general I surf the Internet to find information about the lesson… Sometimes I ask the students to bring their iPads to play educational games… I use from time to time educational games that provide learning in motivating way… (ST9).*

PowerPoint

All of the teachers in their study used a presentation software package to present their lessons. PowerPoint was widely used and only one teacher used the Macintosh equivalent, Keynote, to prepare slides for their lessons. Respondents indicated that they use PowerPoint to display their lessons in an attractive way to draw students' attention and organize the ideas of the lesson. Teachers remarked:

I use the computer in all my lessons to present the lessons using the PowerPoint… (ST10).

… Sometimes I use PowerPoint to display my lesson… (ST12).

… I use PowerPoint some times to display the lesson specially if the topic was hard and needs from students to pay more attention… (ST13).

A teacher indicated that she used a different program to display her lesson; she used Keynote which can be downloaded on the iPad. The usefulness of this application is that it can be edited and displayed on the iPad. However, PowerPoint could not be edited on the iPad and also did not show the animations and other effects.

… Display my lesson on Keynote, it is like PowerPoint… (ST3)

One teacher stated that she used PowerPoint to display student projects. As she remarked:

I used the PowerPoint most of the time for displaying the lesson. I used the computer to display student projects (ST6).

Teachers indicated the benefits of using PowerPoint to display their lessons. As teachers remarked:

Sometimes I use it to present the lessons; it helps in displaying the lesson in an interesting way (ST8).

I use the PowerPoint always in my lessons to display the lesson which is really nice… I used the PowerPoint to present my lesson in interactive way (ST7).

PowerPoint is the most important technology that I use to display my lesson in interactive way by using sounds, pictures (ST4).

Word Processer

Respondents indicated the importance of using the Word Processer to write lesson plans, exams, and work sheets. As teachers remarked:

… I use Word to write the exams and to write the lesson plan… (ST15).

… I use the word processer to write students' exams and work sheets… I write the lessons plans using the word processer… (ST2).

… I used the word processer to write the lessons' plans, tests, worksheets, activities… (ST3).

YouTube

Respondents indicated that they used YouTube to present and download educational movies. As teachers remarked:

I use YouTube to present videos that are related to the topic that I teach… And on YouTube there are many science lessons (ST 2).

… Download and watch YouTube educational videos (ST 5).

For example, one teacher indicated that some lessons are difficult to teach effectively by experimentation. As she declared:

I used YouTube to show the students the volcano because we cannot use the experiment to see the volcano (ST1).

Teachers indicated that the using the educational videos is really useful for teaching science concepts. As respondents declared:

… My use depends on the lesson so I use videos some times because there are a lot of educational video that are useful… (ST13).

I use educational movies to explain some of my lessons they are useful in explaining the new topics and make students pay attention while they are watching these movies… (ST14).

6.3.1.3 Types of other technologies used in the classroom

The major technologies that were used by respondents emerged from the analysis of the interviews. Respondents indicated that science laboratories in their schools contained: TV, DVD player, audio recorder, overhead projector, LCD projector, screen projector, and microscopes. Teachers commented about how the school provides all the materials, tools and technology in the science laboratory, as is evident from these remarks made by respondents:

The science lab is supplied with the tools that we need in teaching science such as microscope, TV, DVD players, audio recorder, overhead projector, LCD projector (ST5).

I have various technologies in the science lab such as, microscopes, overhead projector, audio recorder, TV, and DVD player (ST21).

I use audio recorder, microscopes, overhead projector, document camera, and LCD projector (ST10).

Technology that is available in the science laboratory is important for teachers to conduct their lessons, including doing the experiments. Teachers need to use technology all the time, as is evident from these statements about different types of technology:

We have in the lab TV, DVD player, and microscope. I use them all in my classes (ST2).

…We have the science lab which is equipped with tools like microscope, TV, DVD player, and others that we use all the time… (ST1).

Our science labs are provided by different kinds of technologies that we use them always in our teaching like microscopes, DVD players, overhead projectors, LCD projectors (ST14).

Some schools provided document cameras in addition to the other technologies that were discussed above. As a respondent stated:

There is audio recorder, microscopes, LCD projector, and document camera in the lab (ST11).

However, some schools did not provide the LCD projector or projector screen. As respondents remarked:

We have in the science lab audio recorder, overhead projector, TV, microscopes, and I use these tools in my teaching. But unfortunately, we do not have LCD projector or projector screen (ST12).

We do not have LCD projector and projector screen in the science lab; I use the computer lab some times to display some lessons. But the computer lab is always booked by other teachers (ST21).

… The lab is not equipped with computers, or LCD projector. So I use my laptop and my LCD projector and this thing requires from me to carry my laptop and LCD projector every lesson to the science lab… (ST1).

Teachers indicated that they used these technologies to explain science concepts and to do experiments. As respondents remarked:

The room is supplied with TV, overhead projector, audio recorder, and microscope. I use these tools in teaching. In most of our lessons we use experiments. And we have the room that is supplied with the important tools that we use during the experiments (ST3).

I use the TV to display educational movies and we have a new one. I use also DVD player; I bring my USB and display the videos on TV. Also, I use the microscope, the audio recorder, and overhead projector (ST20).

Teachers also indicated that there is an assistant in the science laboratory who prepares all these materials for the teachers before starting the lesson. As one respondent stated:

…Most of the time I use the tools that are available in the science lab. There is an assistant who helps me in preparing all the materials that I need to use in the classroom. (ST8).

6.3.2 Use of ICT outside the classroom

There were two purposes of uses of ICT outside the classroom that emerged from the analysis of the interviews. These were: 1) educational purposes; and 2) private purposes (see Figure 6.7).

6.3.2.1 Educational purposes

Eleven out of twenty one teachers used ICT for educational purposes. Interviewees indicated that they used the applications that are downloaded on their mobiles, such as Instagram and WhatsApp, to communicate with each other, upload photos regarding the lesson or other educational issues, and to post information for parents and students. As respondents remarked:

The science department has account on Instagram. We post some pictures, information about exams and parents can follow us on Instagram. So they can track *the new improvements and they can ask questions about the subject. Science teachers have group on WhatsApp. We share links, information about science, discuss some educational issues (ST1).*

The school has account on Instagram so all teachers can post any new ideas or photos related to the subject that they teach. And most of the parents are following us on Instagram. I like Instagram because it is useful and easy to use....The science department has group on WhatsApp so we can use it to share ideas and to communicate with each other (ST11).

WhatsApp and Instagram are applications in my phone. The science department has account on Instagram to post information for parents. Our department has group on WhatsApp we use it to send video and audio broadcasts or pictures; or to communicate (ST13).Our department has account on Instagram so we can share new ideas and communicate with parents (ST16).

I have Instagram, WhatsApp in my phone. Our school has account on Instagram which they use it to upload school's news, dates of exams, and dates of parents-teachers interviews. Our department has a group on WhatsApp that we use to discuss the new educational issues. My department has WhatsApp, we use it to communicate and share ideas (ST2).

Our department has group on WhatsApp, it is interesting I really like it, and we chat, send broadcasts, and share different ideas (ST21).

The school has account on Instagram and the science department has an account on Instagram. We use them to post every new issue in our school. Also all teachers in the school have blogs so they can upload new questions for the students and communicate with parents (ST5).

… I post some of the activities that happens during the lesson on Instagram so I get feedback from colleagues and parents, which is good for me as a teacher it helps me to have additional suggestions and ideas… have Instagram but I do not use it to post educational issues. I use WhatsApp to communicate with science teachers and we use it to send information about science which I find it useful (ST6).

… There is an account on the Instagram for school generally, and for science department specially. We use them to post activities and pictures, and any other things that benefit teachers, students, and parents (ST7).

… Actually I use WhatsApp to communicate with teachers and with the head of science department to discuss subjects that are related to the teaching… (ST8).

… I use Instagram to post subjects or pictures that are related to the subject and receive comments from parents or even students. I use WhatsApp to discuss with teachers new ideas that are related to the subject (ST9).

6.3.2.2 Private purposes

Five teachers who had applications (i.e. WhatsApp, and Instagram) downloaded in their mobiles used them only for personal uses. Interviewees indicated that they did not use for educational uses. As respondents remarked:

I have Instagram and WhatsApp I use them for my personal use (ST17).

I have Instagram but I do not use it to post educational issues (ST6).

I do not use the Instagram to post educational subjects (ST8).

One teacher indicated that the science department lacks an account with regard to educational issues. As she remarked:

I downloaded Instagram recently, but my department does not have account on Instagram (ST21).

Another teacher encouraged the use of such applications for educational purposes. As she remarked:

Instagram and WhatsApp I used them for private purposes. But it is good idea to use them in education (ST3).

6.4 Summary of qualitative results

The chapter examined research questions two and three: what are the factors that prevent or encourage science teachers to use ICT in teaching? To what extent do science teachers use ICT in teaching? Four main categories of issues were identified through thematic coding. These issues were: barriers that prevent teachers from using ICT in teaching, incentives that encourage teachers to use ICT in teaching, subjective norms, and the use of ICT to teach science. These issues corresponded well with the factors that were drawn from the quantitative analysis factors discussed in chapter five.

The findings of the qualitative analysis show that the actual use of ICT in the classroom by primary science teachers is focused on practical purposes and ICT is used appropriately when required. Teachers used ICT frequently in their classrooms and they tried to overcome most of the barriers that may hinder them from using ICT in the classroom by, for example, providing their own technologies and materials. They were also positive regarding the use of ICT in teaching which positively affected their intention to use ICT in teaching. This frequent use of ICT in teaching did not prevent teachers from stating that there were barriers that affected their use of ICT in the classroom. The teachers were optimistic that ICT usage can be increased by providing solutions to the problems that teachers often experience when using ICT in the classroom. A summary of the findings was as follows:

1) The use of ICT was influenced by barriers that may hinder teachers from using ICT in the classrooms. There were external and internal barriers that hindered primary science teachers from using ICT in teaching. For example, lack of computers in the classroom and science lab, and lack of latest technology were the major external barriers that affected teachers' use of ICT. However, there were a few teachers who had internal barriers that prevent them from using ICT in teaching.
2) The use of ICT was also affected by incentives that encourage and enhance the use of ICT in teaching by primary science teachers. There were internal and external incentives that encouraged teachers to use ICT in the classroom. The availability of support from administration and the availability of computers and technology respectively were the major

external enablers that encouraged teachers to use ICT in the classroom. The benefit gained from using ICT in teaching was the major internal incentive that encouraged teachers to use ICT in the classroom for teaching science.

3) Other people such as, the principal, or head of department, affected teachers' use of ICT in the classroom. Students were the major influence for teachers to use ICT. The students' achievements and the opportunity for better understanding were enhanced by teaching science with ICT.
4) Some of the factors that affect teachers' use of ICT appeared to be interrelated. Teachers' attitudes toward using ICT in teaching are affected by subjective norms, ease of use, and usefulness. Also, teachers' behavioural intention is affected by perceived ease of use and efficacy in using ICT in teaching. Moreover, perceived ease of using ICT is affected by perceived efficacy in using ICT in the classroom.

In summary, the teachers' beliefs in the benefits of using ICT to teach science were: to clarify information, to enhance students' understanding and to promote higher achievement. For this reason, the teachers would provide their own computers and technology to use in the classroom. However, the existence of many external barriers still hinders the most effective use of ICT for science teaching.

The following chapter provides a full discussion of the results of the questionnaire and the interviews. Moreover, it provides a comparative analysis of the quantitative and qualitative data.

Chapter 7: Discussion, Conclusion and Recommendation

This chapter begins by returning to the research objectives developed to investigate the research questions as these shaped the nature and the scope of the study. This study developed an Information and Communication Technology Acceptance Model (ICTAM) to investigate the factors that affect female primary science teachers' use of ICT in Kuwaiti classrooms. ICTAM was tested with primary female science teachers and the findings are provided in Chapter 5. Investigations using in-depth semi-structured interviews about teachers' perceptions of the existence of additional factors that affect ICT use are provided in Chapter 6. Further discussion on the survey results achieved from testing the model and hypotheses are provided in this chapter. This chapter is divided into 6 sections. Section 7.1 discusses the results of the questionnaire (provided in Chapter 5 survey data analysis). Section 7.2 discusses the results of interviews analysis (provided in Chapter 6 interview data analysis). Section 7.3 provides triangulation of quantitative results with qualitative results. The framework for successful ICT integration is provided in section 7.4. Contribution to theory and practice is addressed in section 7.5. Recommendations for future research are given in section 7.5 and the contribution of the research is discussed in 7.6. Finally, the conclusion is given in section 7.7.

7.1 Discussion of questionnaire results

The results of the questionnaire answer three research questions: 1) how does ICTAM explain female primary science teachers' use of ICT in the classroom? 2) What are the factors that prevent or encourage primary female primary science teachers' use of ICT in teaching? And 3) to what extend do primary science teachers use ICT in teaching?

7.1.1 Measurement model

Structural equation modelling using AMOS software was employed in the current study to analyse data that were collected from primary female science teachers regarding their perceptions of factors that affect their use of ICT in teaching. Structural equation modelling is based on two models: measurement model and structural model. The proposed model's factors were computer self-efficacy, subjective norms, external barriers, usefulness, ease of use, attitude towards using ICT in teaching, intention, and actual use. The findings from examination of the measurement model for primary female science teachers are discussed below, and the final selection of the final items that significantly influence the acceptance of using ICT in teaching science in the classroom is summarized in Table 7.1.

7.1.2 Computer self-efficacy

This study assumed that computer self-efficacy was a key measure of the acceptance of using ICT in teaching by primary science teachers. Most previous research studies have adopted the computer self-efficacy items that were developed by Compeau and Higgins (1995) to measure self-efficacy in using the computer. However, the current study adapted the items that were developed by Anderson and Maninger (2007) which measure teachers' self-efficacy to use the computer in teaching. Six items significantly represented the computer self-efficacy: *1*) *evaluate appropriately* *students' activities and tasks; 3) Create project-based learning activities using a range of instructional strategies for individuals and small/whole groups; 4) plan, select, and implement instruction that allows students to use ICT in problem-solving and decision-making situations; 5) teach students how to locate, retrieve, and retain content-related information from a range of texts and technologies; 6) perform administrative tasks such as taking attendance, maintaining grade books, and facilitating communication; 7) and create a lesson or unit that incorporates subject matter software as an integral part.* However, item 2) *select and use educational software for a defined task according to quality, appropriateness, effectiveness, and efficiency*, was insignificant because the loading factor of this item was below the cut-off value. Therefore, it was removed from the final model, and not included in Table 7.1.

The results from the measurement model confirmed that computer self-efficacy is a valid and reliable construct as a measurement of science teachers' use of ICT in teaching. This finding is in agreement with the results of previous studies undertaken on the integration of technology in teaching (Al-Awidi & Alghazo, 2012; Anderson & Maninger, 2007; Gong, Xu, & Yu, 2004; Hu, Clark, & Ma, 2003; Liaw, Huang, & Chen, 2007; Liu, 2010; Inan & Lowther, 2010; Sang, Valcke, Braak, & Tondeur, 2010; Teo & Schaik, 2012; Yuen & Ma, 2008; Teo, 2009).

7.1.3 External barriers

The external barriers construct was adopted in the current study to evaluate science teachers' acceptance of using ICT in teaching. Thirteen items were adopted from different researchers to represent this construct. Two items were insignificant for measuring the external barriers construct: *Lack of resources (educational software);* and *Lack of using ICT to measure student learning through high-stakes examinations.* Thus, they were not considered in Table 7.1.

The results from the measurement model confirmed that external barriers is a valid and reliable construct as a measurement of science teachers' use of ICT. This finding is in agreement with the results of the previous research studies that examined the validity and the reliability of the external barriers (Brush et al., 2008; Matheieson et al., 2001; Teo, 2009; Teo & Schaik, 2012).

7.1.4 Subjective norms

This study adopted the subjective norms construct to assess the importance of social influences on actual use of ICT in teaching. Previously, this construct was measured by using only one item. However, using a single-item measure has contributed to the weak performance of subjective norms as a predictor (Armitage & Conner, 2001). Hence, researchers have suggested adding other items to test the importance of this construct. Marcinkiewicz and Regstad (1996) identified the other people who were considered as important for teachers. Those people included the principal, colleagues, pupils, and professional bodies. The current study adopted and modified these items that were used by Marcinkiewicz and Regstad (1996), and indicated that the construct showed reliability and validity. In this study, subjective norms which provided a social influence on the actual use of ICT included the principal, head of department, colleagues, supervisor, and student. One item, *parents,* was removed because it contributed only a low value of the loading factor, and was not included in Table 7.1.

The results from the measurement model confirmed that subjective norms is a valid and reliable construct as a measurement of ICT acceptance among science teachers. This finding is in agreement with the results of the studies that adopted this construct to predict the acceptance of technology in teaching (Hu, Clark, & Ma, 2003; Marcinkiewicz & Regstad, 1996; Mulkeen, 2003; Salleh & Albion, 2004; Teo, 2008; Teo, 2010a; Teo, 2010b; Teo & Schaik, 2012; Yuen & Ma, 2008;).

7.1.5 Ease of use

Ease of use is a key measure of the acceptance of using ICT in teaching; and this construct is based on the instrument that was developed by Davis (1989). Six items were adopted to represent this construct. All the items of the ease of use construct were significant, and summarized in Table 7.1.

The results of the measurement model confirmed that ease of use is a valid and reliable construct as a measurement for predicting the use of ICT by science teachers. This finding is in agreement with the results of the studies that adopted this construct to predict the use of technology (Chai, 2008; Chien, Kao, Yeh, & Lin, 2012; Davis, 1993; Gao, 2005;Hu, Clark, & Ma, 2003; Nair & Das, 2012; Teo & Teo, 2008; Teo, 2009; Teo, Lee, Chai, & Wong, 2009; Teo, 2010a; Teo, 2010b; Teo & Noyes, 2011; Teo & Schaik, 2012).

7.1.6 Usefulness

Usefulness is a key measure of the acceptance of ICT usage in the classroom. Six items were adopted from Davis (1989) to represent this construct. However, five items were used to represent this construct. Item number (5) *helps students understand the lessons better* was insignificant to measure the usefulness construct due to the low loading factor and therefore removed from Table 7.1.

The results of the measurement model confirmed that usefulness is a valid and reliable construct as a measurement for predicting the use of ICT by science teachers. This finding is in agreement with the results of the studies that adopted this construct to predict the use of technology (Chien, Kao, Yeh, & Lin, 2012; Davis, 1993; Gao, 2005; Hu, Clark, & Ma, 2003; Liaw, Huang, & Chen, 2007; Nair & Das, 2012; Teo & Chai, 2008; Teo, 2008; Teo, Lee, Chai, & Wong, 2009; Teo, 2009; Teo, 2010a; Teo, 2010b; Teo, 2010c; Teo & Noyes, 2011; Teo & Schaik, 2012).

Usefulness was the strongest predictor of ICT use according to the current study. The finding of the current study is consistent with Pynoo et al. (2011) who found that the usefulness of technology was the main predictor of digital learning environment acceptance.

On the other hand, Chen (2010) found the construct called value was the weakest predictor of technology integration. Moreover, the results of the current study are inconsistent with previous research that found attitude towards using computers was the strongest predictor of computer use (Sang et al., 2010). Also, other previous research studies (Chen, 2010; Watts, 2009) found that technology self-efficacy was the best predictor of teachers' actual use of ICT, which is inconsistent with the finding of the current study.

7.1.7 Attitude toward using ICT in teaching

An attitude scale based on Compeau & Higgins (1995) instrument was selected to assess teachers' attitudes toward using ICT in teaching science in the classroom. Five items were adopted to represent this construct in Table 7.1 because the items of the attitude construct were significant.

The results of the measurement model confirmed that attitude toward using ICT in teaching is a valid and reliable construct as a measurement of predicting the use of ICT by science teachers. This finding is in agreement with the results of the studies that adopted this construct to predict the use of technology (Chien, Kao, Yeh, & Lin, 2012; Davis, 1993; Gao, 2005; Liaw, Huang, & Chen, 2007; Nair & Das, 2012; Sang et al., 2010; Teo & Chai, 2008; Teo, 2008; Teo, Lee, Chai, & Wong, 2009; Teo, 2010a; Teo, 2010b; Teo & Noyes, 2011; Teo & Schaik, 2012).

7.1.8 Behavioural Intention

Behavioural intention scale based on Moon and Kim (2001) instrument was selected in this study to assess teachers' intention toward using ICT in teaching science in the classroom. Six items were adopted to represent this construct in Table 7.1 because the items of the intention construct were significant.

The results of the measurement model confirmed that behavioural intention is a valid and reliable construct as a measurement of predicting the use of ICT by science teachers. This finding is in agreement with the results of the studies that adopted this construct to predict the use of technology (Chai, & Wong, 2009; Chien, Kao, Yeh, & Lin, 2012; Davis, 1993; Gao, 2005; Liaw, Huang, & Chen, 2007; Teo & Chai, 2008; Teo, 2008; Teo, Lee, Teo & Noyes, 2011; Teo & Schaik, 2012).

7.1.9 Actual use of ICT in teaching science in the classroom

Actual use was selected to be the central construct of the acceptance of ICT in teaching. Six items were adapted from the instrument *actual use* (Davis et al., 1989) to measure the teachers' actual use of ICT. However, three items were used to represent this construct and they are summarized in Table 7.1. Three items were insignificant to measure the actual use construct: *(2) How many lessons did you use ICT in your teaching in the week 11&12? ; (4) How many lessons did you use ICT in your teaching in the week 7&8? ; (6) How many lessons did you use ICT in your teaching in the week 3&4?*

The results of the measurement model confirmed that actual use items formed a valid and reliable construct to investigate the actual use of ICT by science teachers. This finding is in agreement with the results of the studies that adopted this construct to investigate the use of technology (Chien, Kao, Yeh, & Lin, 2012; Davis, 1993; Gao, 2005; Sang et al., 2010; Teo & Chai, 2008; Teo, 2008).

Before adopting the model, it was important to assess the literature and establish the most significant items for measuring the acceptance of using ICT in the science classroom. Table 7.1 shows the summary of the significant items in measuring the acceptance of using ICT in teaching science in the classroom

Table 7.2: Summary of the significant items in measuring the acceptance of using ICT in teaching science in the classroom

Construct	Items
(1) Computer self-efficacy	(1) Evaluate appropriately students' activities and tasks (3) Create project-based learning activities using a range of instructional strategies for individuals and small/whole groups (4) Plan, select, and implement instruction that allows students to use ICT in problem-solving and decision making situations (5) Teach students how to locate, retrieve, and retain content-related information from a range of texts and technologies (6) Perform administrative tasks such as taking attendance, maintaining grade books, and facilitating communication (7) Create a lesson or unit that incorporates subject matter software as an integral part.
(2) External barriers	(2) Lack of professional development opportunities on using ICT in teaching (3) Lack of access to the Internet (4) There is not enough time in class to implement technology-based lessons (5) Technology-integrated curriculum projects require too much preparation time (6) Lack of technical support (7) Lack of support from school administrators, parents, or other teachers (8) Lack of technology-integration plan (9) Lack of leadership (10) Pressure of High-stakes examinations
(3) Subjective norms	(1) Principal (2) Head of department (3) Colleague (4) Supervisor (6) Student
(4) Ease of use	(1) Learning to use ICT in teaching is easy for me (2) I find it easy to use ICT in teaching if I want to use it (3) My interaction with ICT in teaching is clear and understandable (4) I find using ICT in teaching enables more flexible interaction (5) It is easy for me to become skilful at using ICT in teaching (6) I find ICT easy to use in my teaching
(5) Usefulness	(1) Enables me to teach more quickly (2) Improves my teaching performance (3) Enhances my effectiveness in present teaching materials (4) Makes lessons more motivating (6) Develops students' learning skills
(6) Attitude toward using ICT in teaching	(1) Using ICT in teaching is interesting (2) Using ICT in teaching is fun (3) I like using ICT in teaching (4) I look forward to those aspects of teaching that require me to use ICT (5) Once I get using ICT in teaching, I find hard to stop
(7) Intention	(1) I intend to use ICT in teaching when it becomes available in my school

Construct	Items
	(2) I intend to use ICT in teaching as often as possible (3) I intend to use ICT in teaching on a regular basis in the future (4) I intend to recommend strongly to others to use ICT in teaching (5) I intend to use ICT in teaching in future (6) I intend to use ICT in teaching often
(8) Actual use of ICT in teaching	(1) How many lessons did you use ICT in your teaching in the week 1 & 2? (3) How many lessons did you use ICT in your teaching in the week 5 & 6? (5) How many lessons did you use ICT in your teaching in the week 9 & 10?

7.1.10 The structural model and hypotheses

The structural model is used to test the relationships between the constructs of the proposed model and 27 hypotheses formulated to examine these relationships. A proposed Information and Communication Technology Acceptance Model (ICTAM) is suggested in the current study. The assessment results of ICTAM indicated a good fit in explaining and predicting primary science teachers' acceptance of ICT in teaching.

Considering the strength of ICTAM; the selected constructs are inter-dependent and co-dependent, which is consistent with the validity of the SEM. However, not all of the constructs are significant. Based on the goodness of fit, the most important constructs are perceived usefulness and ease of use. The results demonstrated that the variable ease of use has the greatest influence on usefulness, while computer self-efficacy has the second greatest influence on ease of use. In turn, the variable usefulness has the third greatest influence on attitude toward using ICT in teaching, and this result is consistent with Teo's (2010) research study. Considering the relationships between the variables in details, the variable subjective norms has significant influence on computer self-efficacy, attitude toward using ICT in teaching, usefulness (Teo, 2010; Yuen & Ma, 2008), and external barriers. These results indicated that subjective norms (e.g. Principal, students, head of department, or supervisor) are important for teachers to use ICT in teaching and affect positively their perceived usefulness and attitude toward using ICT in teaching. Also, teachers' opinions about the existence of external barriers are affected negatively by the opinions of other people. Teachers attempt to overcome the barriers that affect their use of ICT because they find that the encouragement and support from the other people enhance their use of ICT in the classroom. However, the variable subjective norms has insignificant influence on ease of use compared to Yuen and Ma's (2008) study result. The result of the current study indicated that other people do not affect teachers' opinions about the ease of using ICT in teaching. In turn, the current study results indicated that the efficacy of using computers in teaching is the factor that affects teachers' perceptions about the ease of using ICT in teaching. Consider another relationship with the variable subjective norms; this variable has insignificant effect on intention. This result was supported by previous research studies (Ma, Andersson, & Streith, 2005; Yuen & Ma, 2008).

Also, the variable external barriers has insignificant influence on ease of use. Moreover, the variable perceived external barriers has insignificant effect on computer self-efficacy, usefulness, and intention. In turn, the variable computer self-efficacy has significant influence on ease of use (Teo, 2010; Liu, 2010; Yuen & Ma, 2008). Furthermore, computer self-efficacy has significant effect on intention. This result was consistent with Anderson and Maninger (2007) study. However, this result was different from Yuen and Ma (2010) who found that computer self-efficacy had insignificant effect on intention. Also, the variable computer self-efficacy has significant effect on usefulness compared to Liu's (2010) study result who found that computer self-efficacy had insignificant effect on usefulness. Moreover, the variable ease of use has significant influence on attitude toward using ICT in teaching (Nair & Das, 2012; Teo, 2010), usefulness (Gao, 2005; Nair & Das, 2012; Teo, 2010; Liu, 2010), and intention (Liu, 2010). Additionally, the variable usefulness has significant influence on attitude toward using ICT in teaching which was supported by previous research studies (Gao, 2005; Teo, 2010). However, this result was different of a previous research study that found the variable usefulness had negative insignificant effect on attitude (Nair & Das, 2012). Moreover, the variable usefulness has significant effect on intention (Gao, 2005; Liu, 2010). Additionally, the variable attitude toward using ICT in teaching has significant influence on intention (Gao, 2005; Teo & Schaik, 2012), and actual use of ICT. Moreover, the variable intention has significant influence on actual use of ICT in teaching (Gao, 2005; Liu, 2010). Furthermore, computer self-efficacy significantly affects ease of use, and the usefulness affects the attitude of primary science teachers to implement ICT in their teaching. Lastly, there is an indirect relationship between the effect of computer self-efficacy on attitude towards ICT which is fully mediated by ease of use

From these results, the greatest effect was the effect of ease of use on usefulness. This result showed that usefulness and ease of use were the key determinants of actual use of ICT. On the other side, the effect of attitude on intention was greater than the effect of attitude on actual use of ICT. This result indicated that teachers' positive attitudes affect directly on their intention to use ICT in teaching.

The discussion of hypotheses is overviewed based on the relationships between the eight constructs of the proposed ICTAM. The paragraphs below discuss these hypotheses in detail.

7.1.10.1 Computer self-efficacy hypotheses

Based on the study model relationships, computer self-efficacy is hypothesised to be a determinant of four constructs: ease of use; usefulness; attitude; and intention. Accordingly, four hypotheses were formulated to examine these relationships. The results of these hypotheses are discussed below.

H1: Computer self-efficacy significantly and directly affects ease of use

The results of data analysis and testing the hypotheses confirmed that hypothesis H1 is supported. Computer self-efficacy plays a significant role in enhancing the perceived ease of use via increasing teachers' confidence to use the computer in the classroom. This confidence in using the computer gives the teachers the feeling that using the computer is easy and free of effort.

The finding of the current study is consistent with results of a study by Yuen and Ma (2008) who found that computer self-efficacy had a significant effect on perceived ease of use. Furthermore, the result is consistent with Hu et al. (2003) who found that ease of use is affected significantly and directly by computer self-efficacy.

However, the result of this study is inconsistent with the result of Teo (2009) who found that the computer self-efficacy had insignificant direct effect on perceived ease of use. Teo (2009) attributed the insignificant relationship between computer self-efficacy and ease of use to the similarity of the items of these two constructs, computer self-efficacy and ease of use, due to adapting the items that were developed by Compeau and Higgins (1995) and Davis (1989) respectively. Comparatively, the use in the current study of a different source for the self-efficacy items has made it more distinct from the perceived ease of use scale.

H2: Computer self-efficacy significantly and directly affects usefulness

The results of data analysis and testing of the hypotheses demonstrated that hypothesis 2 is confirmed. Computer self-efficacy plays a significant role in enhancing the perceived usefulness for primary science teachers via increasing teachers' teaching and learning performance, and helping students to understand the lesson more quickly. The confidence in using the computer/ICT to evaluate students' activities, and create project-based learning activities can be considered essential practices to support science teachers in achieving their tasks. This finding is consistent with the result of Teo (2009) who found that computer self-efficacy had significant direct effect on perceived usefulness.

H3: Computer self-efficacy significantly and directly affects attitude

The results of data analysis and testing of the hypotheses rejected hypothesis 3 because there was no direct relationship between computer self-efficacy and attitude toward using ICT in teaching. The relationship between computer self-efficacy and attitude is fully mediated by ease of use. Therefore the arrow from the construct computer self-efficacy to attitude toward using ICT in teaching was removed.

Teachers' confidence in using ICT in teaching is the key factor in enhancing the ease of using ICT in teaching and then the latter enhances teachers' sense of enjoyment and fun in using ICT in the classroom.

H4: Computer self-efficacy significantly and directly affects behavioural intention

The results of data analysis and testing the hypotheses confirmed that hypothesis 3 is supported. Computer self-efficacy plays a significant role in enhancing the primary science teachers' behavioural intention via affecting teachers' willingness to use ICT in teaching. Their confidence in using the computer to explain new topics to students can be considered essential to encourage the practice of using ICT in the classroom, which in turn enhances teachers' intentions to use ICT regularly.

The finding of the current study is consistent with Hu et al. (2003) who found that teachers' behavioural intention is significantly and directly affected by computer self-efficacy. Moreover, Teo (2009) found that the perceptions of pre-service teachers regarding computer self-efficacy had significant effect on behavioural intention. In particular, Wu et al. (2008) found that perceived computer self-efficacy of the science teachers significantly affected their behavioural intention.

7.1.10.2 Subjective norms hypotheses

Based on the study model relationships, subjective norms are hypothesised to be a determinant of six constructs: external barriers; computer self-efficacy; ease of use; usefulness; attitude; and intention. Accordingly, hypotheses H5-H10 were formulated to examine these relationships. The results of these hypotheses are discussed below.

H5: Subjective norms significantly and directly affect perceived external barriers

Hypothesis 5 was formulated to examine the influence of subjective norms on teachers' perceived external barriers. The results support hypothesis 5. The impact of subjective norms on perceived external barriers was significant but negative. Teachers' sense of the importance of the students, principal, supervisor, colleagues, or head of department plays a significant role in damping the sense of the existence of external barriers. The causal relationship between subjective norms and perceived external barriers has not been tested by previous research studies. The supportive result of this study opens the door for other researchers to investigate this relationship in different contexts.

H6: Subjective norms significantly and directly affect computer self-efficacy

The results of the data analysis and testing of hypotheses confirmed that hypothesis H6 is achieved. Principal, head of department, supervisor, or colleagues' opinions about the importance of ICT in teaching science make the teachers more confident in using the computer in teaching science. The support from these people gives the teachers the motivation to learn how to use the computer more effectively in teaching. This relationship (subjective norms and computer self-efficacy) has not been tested before. This supportive result demonstrates the importance of other people in enhancing teachers' confidence and efficacy in using ICT in teaching.

H7: Subjective norms significantly and directly affect ease of use

The results of the data analysis and testing of hypothesis H7 were not supported. Principal, head of department, supervisor, or colleagues' opinions about the importance of ICT in teaching science did not increase teachers' perceptions that computer was easy to use in science.

Support from other people does not affect teachers' perceptions regarding the effortlessness of using ICT in teaching. If the teacher has difficulty in using ICT, the support from the principal, head of department, or supervisor would not make the computer seem easy to use by the teacher just because he/she has the support. The relationship between subjective norms and ease of use has not been investigated previously and the result of the current study demonstrates the insignificant relationship between those two factors. This causal relationship can be tested in different contexts or different countries to see if the results of the new research support the results of the current study or not.

H8: Subjective norms significantly and directly affect usefulness

Hypothesis H8 shows the insignificant influence of subjective norms on perceived usefulness. The findings of the study showed that this hypothesis is not supported. The opinion of principal, head of department, supervisor, or colleagues does not have influence on science teachers' perceptions of computers enhancing teaching performance and productivity. The finding of this study is consistent with Ma et al.

(2005) who found that teachers' subjective norms had insignificant impact on their perceptions of the usefulness of computers. However, the finding of the current study is inconsistent with Teo (2010a) who found that subjective norms had a significant direct effect on per-service teachers' perceptions of the usefulness of computers. Also, Hu et al. (2003) found that subjective norms had a significant negative direct effect on perceived usefulness. In other words, the social pressure negatively affected teachers' perceptions regarding the importance of technology to enhance teachers' teaching performance and productivity (Hu et al., 2003).

H9: Subjective norms significantly and directly affect attitude

The results of the data analysis and testing supported hypothesis H9. Other people's opinions about the importance of using ICT to make teaching more fun and interesting enhances teachers' motivation and attitude to use ICT in teaching. The result of the current study is consistent with the result of Ajzen and Fishbein (1980) and Chang (1998) who found that subjective norms had significant effect on attitude toward behaviour.

H10: Subjective norms significantly and directly affect behavioural intention

Hypothesis H10 shows the insignificant influence of subjective norms on teachers' perceived behavioural intention. Other people's opinions do not have influence on teachers' perceptions regarding willingness to use the computer regularly in future.

This result is consistent with Hu et al. (2003) who found that the perceptions of school teachers regarding the subjective norms had insignificant direct effect on behavioural intention. Moreover, Birch and Irvine (2009) found that pre-service teachers' perceptions of social influence had insignificant effect on behavioural intention. In addition, Teo (2011) who undertook his research with teachers found that subjective norms had insignificant effect on behavioural intention.

7.1.10.3 External barriers hypotheses

Based on the study model relationships external barriers are hypothesised to be determinants of four constructs: computer self-efficacy; ease of use; usefulness; and intention. Accordingly, four hypotheses were formulated to examine these relationships. The results of these hypotheses are discussed below.

H11: External barriers significantly and directly affect computer self-efficacy

The study results show that hypothesis H11 is not supported. We can assume from this result that the primary science teachers could be skilled in using the computer in teaching and this confidence and capability to use the computer in teaching might reduce the feeling of science teachers about the existence of the external barriers.

H12: External barriers significantly and directly affect ease of use

Hypothesis H12 was not supported showing the insignificant influence of external barriers on teachers' perceived ease of use. The main justification of the insignificant relationships between external barriers and ease of use could be that the teachers find using ICT in teaching is easy and free of effort.

H13: External barriers significantly and directly affect usefulness

Testing the hypothesis H13 shows that the effect of external barriers on perceived usefulness was insignificant. Perceived external barriers have insignificant effect on perceived usefulness. In other words, the perception of lack of time, computers, and technical support to hinder teachers from using ICT in teaching has unimportant influence on how much the use of ICT enables the teacher to be more productive.

The results of the current study are consistent with Teo (2009) who found that facilitating conditions had insignificant effect on perceived usefulness. However, the results of this study are inconsistent with Teo (2011) who found that facilitating conditions had significant influence on perceived usefulness.

H14: External barriers significantly and directly affect intention

The outcomes of analysis show that hypothesis 14 is not supported. The justification of the insignificant relationship between external barrier and intention is that the teachers intend to use ICT in teaching regularly in future despite the lack of computers, internet, time, and support.

The result of the current study is inconsistent with Teo (2011) who found that facilitating conditions had a significant effect on behavioural intention. Whereas, Matheison et al. (2001) found that perceived resources had significant influence on behavioural intention.

7.1.10.4 Ease of use hypotheses

Based on the study model relationships ease of use is hypothesised to be a determinant of three constructs: usefulness; attitude toward using ICT; and intention. Accordingly, three hypotheses were formulated to examine these relationships. The results of these hypotheses are discussed below.

H15: Ease of use significantly and directly affects usefulness

Examination of the study hypotheses showed that ease of using ICT in teaching plays a key role in supporting the usefulness of using ICT in teaching according to perceptions of science teachers. This result supports hypothesis 15. The results of the current study found that the variable ease of use has the greatest influence on usefulness. This result is consistent with Davis (1989) who developed the Technology Acceptance Model.

Ease of use is related to ease of use of the ICT, interaction in teaching, flexibility, and becoming skilful. Perceived usefulness focuses on the role of ICT to enhance teachers' performance and develop students' learning skills. According to the study findings, the ease of using ICT in teaching contributes to the perceived usefulness of this use and enriches teachers' performance and productivity.

The results of testing H15 are consistent with the findings of studies by Hu et al. (2003), Ma et al (2005); Nair and Das (2012); Teo et al. (2009), Teo (2010a), and Teo (2011) who found that perceived ease of use significantly and directly affected perceived usefulness.

However, the result of testing this hypothesis is inconsistent with the finding of Wu et al. (2008) who undertook their study with science teachers and found that ease of use had significant negative effect on usefulness. In other words, the ease of using IT did not necessarily contribute to enhancing the science teachers' teaching performance.

H16: Ease of use significantly and directly affects attitude toward using ICT

The results of data analysis and testing the hypotheses confirmed that hypothesis H16 is supported.

All the five attitude indicators were significant in measuring science teachers' attitude toward using ICT in teaching: ICT interesting; ICT fun; I like ICT; looking forward to use ICT teaching aspects; once I get using ICT, I find it hard to stop. Ease of using ICT in teaching appeared as a determinant of user attitude based on science teachers' perceptions. The impact of ease of use of ICT on teacher attitude can be explained by the ease of learning to use ICT in teaching which means that the use of ICT does not require a lot of effort; and thus, enhances attitudes toward using ICT in teaching.

The finding of the current study is consistent with Nair and Das (2012), Teo (2010a), Teo (2011), and Teo and Noyes (2011) who found that attitude towards using technology significantly and directly affected perceived ease of use.

H17: Ease of use significantly and directly affects behavioural intention

The results of data analysis and testing the hypotheses confirmed that hypothesis H17 is supported.

The critical role of ease of using ICT to enhance science teachers' intention toward using ICT in teaching has been investigated and confirmed in the current study. The aspects of ease of using ICT, flexibility; are deemed to be essential for science teachers' intention to use ICT in teaching on a regular basis in future; and intention to use ICT in teaching when it becomes available in school.

The finding of the current study is consistent with Phua et al. (2012) who found that ease of use had a significant influence on behavioural intention. However, the finding of this study is inconsistent with Hu et al. (2003) who found that perceived ease of use had insignificant negative impact on behavioural intention. Moreover, the result of this study is inconsistent with Ma et al. (2005) who found that teachers' perceptions of ease of using computers had insignificant effect on their behavioural intention. Also, Wu et al. (2008) found that science teachers' perceptions of the ease of using IT in teaching insignificantly affected their behavioural intention.

7.1.10.5 Usefulness hypotheses

Based on the study model relationships, usefulness is hypothesised to be a determinant of two constructs: attitude toward using ICT; and intention. Accordingly, two hypotheses were formulated to examine these relationships. The results of these hypotheses are discussed below.

H18: Usefulness significantly and directly affects attitude toward using ICT

Hypothesis H18 emphasizes the significant influence of usefulness on attitude toward using ICT in teaching. The findings of the study showed that this hypothesis is supported.

The results indicate that usefulness is a key determinant of attitude toward using ICT in teaching science. The positive attitude toward using ICT in teaching emphasizes enhanced teaching performance, effectiveness in presenting teaching materials, and developing students' learning skills via the use of ICT. The interest in teaching science using ICT depends on how useful ICT is for teachers in the classroom.

The result of this study is in agreement with Teo (2010a) who found that pre-service teachers' perceptions of usefulness had significant effect on their attitudes toward computer use. In addition, Teo and Noyes (2011) who undertook their study with pre-service teachers found that perceived usefulness had significant effect on attitude toward use.

However, the findings of the current study are inconsistent with Nair and Das (2012) who found that teachers' attitude toward using technology is insignificantly affected by perceived usefulness.

H19: Usefulness significantly and directly affects behavioural intention

The results of the current study support hypothesis H19. Perceived usefulness plays a positive role in enhancing teachers' intention to use ICT in teaching science. The improvement in the teachers' performance and productivity due to use of ICT in teaching science can be credited with producing positive intention of teachers toward using ICT in the class room regularly in the future.

Studies on pre-service teachers such as those by Teo (2009), and Teo et al. (2009) support the significant influence of perceived usefulness on behavioural intention. Moreover, studies on school teachers such as those by Hu et al. (2003), Ma et al. (2005), Phua et al. (2012), Teo (2011), and Wu et al. (2008) found that both perceived ease of use and usefulness significantly and directly affected behavioural intention. In addition, Smarkola (2007) who undertook her study with student teachers and experienced classroom teachers found that perceived usefulness of both teacher groups had significant effect on their behavioural intention.

7.1.10.6 Attitude toward using ICT hypotheses

Based on the study model relationships, attitude is hypothesised to be a determinant of two constructs: behavioural intention; and actual use of ICT. Accordingly, two hypotheses were formulated to examine these relationships. The results of these hypotheses are discussed below.

H20: Attitude toward using ICT significantly and directly affects behavioural intention

The results of the current study support hypothesis H20. Attitude toward using ICT in teaching plays an important role in enriching teachers' intention to use ICT in the classroom. The interest and fun in the teachers' feelings about using ICT in teaching can be responsible for producing positive intention of teachers toward using ICT in the classroom often and positive intention to recommend others to use ICT in teaching. The relationship between attitude towards using ICT in teaching and behavioural intention in the current study was strong compared to the result of the testing this relationship in the original TAM. Davis et al. (1989) demonstrated that the attitude towards using technology modestly affects behavioural intention.

The results of the current study are in agreement with Teo (2009), and Teo et al. (2009) who found that pre-service teachers' intention to use computers is affected by their attitude towards computer use. Moreover, the findings of this study are consistent with Phua et al. (2012) and Teo (2011) who found that attitude toward using the Internet in teaching had a significant influence on behavioural intention. However, the result of the current study is inconsistent with Teo and Noyes (2011) who found that pre-service teachers' attitude toward using technology had insignificant effect on behavioural intention.

H21: Attitude toward using ICT significantly and directly affects actual use of ICT in teaching

The results of data analysis and testing the hypotheses confirmed that hypothesis H21 supported teachers' positive attitude toward using ICT in teaching as an important factor that increases teachers' frequent use of ICT in the classroom.

7.1.10.7 Behavioural intention hypothesis

Based on the study model relationships, behavioural intention is hypothesised to be a determinant of one construct: actual use of ICT. Accordingly, one hypothesis was formulated to examine this relationship. The result of testing this hypothesis is discussed below.

H22: Behavioural intention significantly and directly affects actual use of ICT in teaching

The findings of the current study supported hypothesis 22. Having a positive intention toward using ICT in the classroom regularly in the future and recommending others to use ICT in teaching, play an important role in increasing the frequent use of ICT in the classroom. This finding is supported by Davis et al. (1989), Taylor and Todd (1995), and Venkatesh and Davis (2000) who found that intention had significant effect on actual use.

7.1.11 Mediation effect hypotheses

The second type of relationship in the proposed ICTAM is the mediation effect. Usefulness and ease of use were selected to play a role of mediation in the current study model.

7.1.11.1 Ease of use mediation effect hypotheses

Based on the study model mediation relationships, ease of use was selected to play a mediation role in the proposed ICTAM. Two hypotheses were formulated to investigate the mediation effect in the proposed model. Results of testing these hypotheses are discussed below.

H23: The effect of computer self-efficacy on attitude is partially mediated by ease of use

The findings of the current study supported hypothesis 23. The effect of computer self-efficacy on attitude toward using ICT in teaching occurs via perceived ease of use. In regard to this relationship, the confidence in using ICT in teaching can contribute to supporting positive attitude of science teachers towards using ICT as a fun way of classroom teaching. This positive attitude cannot be achieved without considering the aspects of ease of use such as clear and understandable interaction with ICT in teaching and ease in becoming skilful at using ICT in teaching.

H24: The effect of subjective norms on attitude is partially mediated by ease of use

The study results show that hypothesis H24 is not supported. The mediation role of ease of use between subjective norms and attitude is not confirmed. The effect of subjective norms on attitude toward using ICT in teaching is direct, and without the mediation of ease of use. In regard to this relationship, support from principal, supervisor, colleagues, head of department or students to teachers regarding the use ICT in teaching leads to a positive attitude toward using ICT in teaching. The main role of others is to provide support and motivation for teachers which help them to like using ICT in teaching regardless of the difficulty or ease of using ICT in teaching. It is worth mentioning that the direct effect of subjective norms on ease of use was insignificant, as shown in testing hypothesis 7.

7.1.11.2 Usefulness mediation effect hypotheses

Usefulness was selected to play a mediation role in the proposed ICTAM. Three hypotheses were formulated to investigate the mediation effect in the proposed model. Results of these hypotheses are discussed below.

H25: The effect of computer self-efficacy on intention is partially mediated by usefulness

The results show that hypothesis H25 is not supported. The mediation role of usefulness between computer self-efficacy and intention is not confirmed. This insignificant relationship is justified by the fact that science teachers' confidence in using ICT in teaching enhances their intention to use it as often as possible or to recommend others to use it in teaching regardless of the effectiveness of using ICT in teaching and learning such as improving the teaching performance and developing students' learning skills.

H26: The effect of subjective norms on intention is partially mediated by usefulness

The findings of the current study do not support hypothesis H26. This insignificant mediation role of usefulness can be justified by the fact that the role of the others in teachers' perspective is not to enrich teachers' intention to use ICT in their teaching such as using ICT on a regular basis, or use it in teaching as often as possible. However, the support and encouragement of the others such as principal, supervisor, colleagues, head of department, or students directly enriches science teachers' teaching performance and productivity. It is worth mentioning that the direct effect of subjective norms on intention was not significant, as shown in testing hypothesis H10.

H27: The effect of external barriers on intention is partially mediated by usefulness

The results of this study do not confirm hypothesis H27. This insignificant mediation role of usefulness can be justified by the fact that the presence of external barriers such as lack of time, Internet, computers, or technical support are important barriers but not in the sense of preventing science teachers from using ICT in teaching, because the teachers are aware of the usefulness and the importance of using ICT in teaching. It is worth mentioning that the direct effect of external barriers on usefulness and intention was not significant, as shown in testing hypotheses H13 and 14, respectively.

To summarise, the results of the 27 hypotheses were discussed in section 7.2. The discussion was supported by literature reporting research on technology use in the classroom. The justifications and explanations about relationships between variables in the proposed ICTAM were provided. Table 7.2 shows a summary of the findings of hypotheses.

Table 7.3: Decisions about hypotheses

		Hypotheses	Decision
Computer self-efficacy	H1	Computer self-efficacy significantly and directly affects ease of use	Accepted
	H2	Computer self-efficacy significantly and directly affects usefulness	Accepted
	H3	Computer self-efficacy significantly and directly affects intention	Accepted
	H4	Computer self-efficacy significantly and directly affects attitude toward using ICT	Removed
Subjective norms	H5	Subjective norms significantly and directly affects ease of use	Rejected
	H6	Subjective norms significantly and directly affect usefulness	Rejected
	H7	Subjective norms significantly and directly affect computer self-efficacy	Accepted
	H8	Subjective norms significantly and directly affect attitude toward using ICT	Accepted
	H9	Subjective norms significantly and directly affect computer behavioural intention	Rejected
	H10	Subjective norms significantly and directly affect external barriers	Accepted
External barriers	H11	External barriers significantly and directly affect computer self-efficacy	Rejected
	H12	External barriers significantly and directly affect ease of use	Rejected
	H13	External barriers significantly and directly affect usefulness	Rejected
	H14	External barriers significantly and directly affect behavioural intention	Rejected
Ease of use	H15	Ease of use significantly and directly affects usefulness	Accepted
	H16	Ease of use significantly and directly affects attitude toward using ICT	Accepted
	H17	Ease of use significantly and directly affects behavioural intention	Accepted
Usefulness	H18	Usefulness significantly and directly affects attitude toward using ICT	Accepted
	H19	Usefulness significantly and directly affects behavioural intention	Accepted
Attitude toward using ICT	H20	Attitude toward using ICT significantly and directly affects behavioural intention	Accepted
	H21	Attitude toward using ICT significantly and directly affects actual use of ICT	Accepted
Behavioural intention	H22	Behavioural intention significantly and directly affects actual use of ICT	Accepted
Mediation effect of ease of use	H23	The effect of computer self-efficacy on attitude is mediated partially by ease of use	Accepted
	H24	The effect of subjective norms on attitude is mediated partially by ease of use	Rejected
Mediation effect of usefulness	H25	The effect of computer self-efficacy on intention is mediated partially by usefulness	Rejected
	H26	The effect of subjective norms on intention is mediated partially by usefulness	Rejected
	H27	The effect of external barriers on intention is mediated partially by usefulness	Rejected

7.1.12 The final model

The study focused on measuring the validity and reliability of the proposed Information and Communication Technology Acceptance Model (ICTAM). The data set from science teachers was analysed using structural equation modelling. Indicators were used to measure the validity and reliability of the proposed model (ICTAM). All the indicators of the proposed (ICTAM) confirmed the validity and reliability of the model to measure the acceptance of ICT.

Regarding the final model, goodness-of-fit indices were used to measure the model fit (Section 5.4.3.4). The validity of the proposed model to measure the acceptance of ICT was confirmed. The assessment results of ICTAM indicated a good fit in explaining and predicting primary science teachers' acceptance of ICT in teaching. External barriers and subjective norms explain 25% of the variance in teachers' computer self-efficacy; computer self-efficacy, external barriers, subjective norms, and ease of use explain 40% of the variance in teachers' ease of using ICT in teaching; computer self-efficacy, external barriers, and subjective norms explain 72% of the variance in teachers' usefulness, and 80% of the variance in teachers' attitude toward using ICT in teaching; while external barriers, subjective norms, computer self-efficacy, ease of use, usefulness, and attitude toward using ICT in teaching explain 83% of the variance in intention. In turn, attitude toward using ICT in teaching and behavioral intention explain 34% of the variance in teachers' actual use of ICT in teaching. This result is consistent with the original technology acceptance model (Davis, 1989). Therefore, this confirms the reliability and validity of the model used in this study.

7.2 Discussion of interview results

The results of the interviews sought to answer the second and the third research questions about the factors that affect female primary science teachers' use of ICT in the classroom; and the extent to which female science teachers use ICT in teaching. The in-depth interviews with science teachers identified their perceptions about the barriers, incentives, and subjective norms that may hinder or encourage them to use ICT in teaching, and their actual use of ICT in teaching.

7.2.1 Barriers

The results of the interviews showed that there were two types of barriers: external barriers and internal barriers. The external barriers were: 1) inappropriateness of ICT for some science topics, 2) lack of computers, 3) lack of experience to use computers, 4) lack of Internet, 5) lack of latest technology, 6) lack of professional development opportunities, 7) lack of resources, 8) lack of support from school administration, 9) lack of technical support, 10) lack of technology-integration plan,

11) lack of time in the classroom, 12) lots of tasks, 13) pressure of high-stakes examinations, and 14) technology-integrated curriculum projects require too much preparation time. The internal barriers were: 1) difficulty to use, 2) negative attitude; 3) negative peer pressure; 4) pedagogical beliefs.

The qualitative analysis showed that lack of computers, lack of Internet, and lack of latest technology were the major external barriers that influenced teachers' use of ICT in teaching; it is suggested that providing this essential equipment in schools makes it easier for teachers to implement ICT in teaching. The current study demonstrated that the existence of such barriers was not preventing the teachers from using ICT in teaching; teachers endeavoured to overcome these barriers by providing their own laptops, Internet, and LCD projectors. This result is consistent with Ertmer et al. (2012) who found that teachers brought their own equipment to facilitate student learning.

According to the current study, lack of computers was a major barrier that hindered science teachers from using ICT in teaching. Computers were available only in the computer labs which made it hard for teachers to access these computers all the time. Moreover, science teachers always used the science labs to conduct their experiments and these labs lacked the computers. This result is consistent with previous research studies (Becta, 2004; Hudson et al., 2008; Lim & Khine, 2006) that found that lack of computers was an important barrier that influenced teachers' use of ICT in teaching. The reliability and validity of the model used in this study was supported by the interviews because there were similar responses (the means for the perceived external barriers items ranged between 1.61-1.82) when the descriptive indicators of perceived external barriers were considered by the teachers

Lack of Internet was also a major barrier that influenced science teachers' use of ICT. Teachers were blocked from surfing the Internet, using the Internet was limited to entering the students' grades. This result is consistent with Alsulaimani (2012) who found that despite the availability of Internet within schools, the lack of Internet connection impacted Saudi science teachers' use of ICT in the classroom.

Lack of latest technology is another major barrier that impacted teachers' use of ICT in the classroom. The absence of technologies such as LCD projectors, Interactive whiteboards, or document cameras discourages the learning process and reduces student achievement. Aldhafeeri, Almulla, and Alraqas (2006) indicated that the Kuwait education system still lacks the latest tools that enhance students' productivity and help students to engage with real-life problems.

The second major barriers that impacted teachers' use of ICT were Lack of time in the classroom, lots of tasks, and too much time utilized to prepare lesson plans that integrate ICT. The lack of time in the classroom was a barrier for teachers because the time allocated for each class is only 40 minutes, the curriculum is very large, too many topics are included in the syllabus and it is hard to cover all these topics in a short time; most of the time is taken up in just preparing the technology equipment, plugging in, and starting the program. This result is consistent with previous research studies that found that using technology was a burden on teachers' time (Brush et al., 2008; Kopcha, 2012)

The additional tasks (such as morning assembly activities, workshops, competitions, celebrations preparation, and schools visit) assigned to the teachers were also barriers for teachers because teachers consume too much time, effort, and money on these tasks, leading to the depletion of teachers' energy and reduction of their use of ICT in teaching. This barrier is unique as it was not mentioned in previous research studies.

Another barrier that impacted teachers' use of ICT in teaching was the time spent in preparing the lessons that have ICT integrated. Similar results were observed in Lim and Khine's (2006) research study where ICT-mediated lessons needed a large amount of time. Lim and Khine (2006) indicated that the teachers spent a lot of time to surf the Internet and preview CD-ROMs to find movies and animation clips to use them in their ICT-integrated lessons. Similarly, Brush et al. (2008) demonstrated that the time pre-service teachers spent to prepare lessons supported by technology was too much which prevented them from using technology in instruction.

The barriers which ranked third in terms of importance were lack of experience to use computers, lack of support from school administrators, lack of technology integration plan, and pressure of high-stakes examinations. Lack of experience to use computers in teaching was one of the barriers given by teachers for not using ICT. Not having sufficient experience in using ICT in the classroom leads to allocating more time and effort in doing the activities that require using technology. Similar results were found in a study on pre-service teachers, where lack of knowledge about technology was a key barrier that hindered pre-service teachers from using technology in teaching (Brush et al., 2008). Moreover, a study conducted by Aytekir, AbdulAziz, Barakat, and Abdelrahman (2012) demonstrated that despite the availability of the interactive whiteboards, teachers were not using them effectively in teaching due to the lack of experience in using technology.

Lack of support from school administration was another barrier that affected the integration of ICT in teaching. The lack of support from the principal or head of department can lead to decreasing teachers' motivation to use ICT in teaching. However, despite the support from school administration regarding the use of ICT in teaching, the problems of integrating ICT in teaching practice could be attributed to the non-compulsory nature of ICT usage in the classroom that deters principals from instructing teachers to use ICT in teaching (Tondeur, Keer, Braak, & Valcke, 2008).

Another barrier was the lack of a technology integration plan. The finding of the current study is similar to that of Ward and Parr (2010), who attributed low levels of ICT use to lesson planning and preparation. According to their observation, "the initial cost, in terms of the time needed to develop computer-based material, is perceived as too high for the results achieved" (p. 120). Pressure of high-stakes examinations was also a barrier that influenced teachers' use of ICT in teaching. The result of the current study is similar to the result of Jimoyiannis (2010) who found that the need to prepare students for the final exams was one of the main difficulties for integrating ICT in science classrooms.

The minor external barriers that influenced teachers' use of ICT in teaching were inappropriateness of ICT for some topics, lack of resources, lack of technical support, and students' numbers in the classroom. The barrier of inappropriateness of ICT for some topics is related to the fact that some of the topics that exist within the science curriculum require the use of real objects rather than ICT. This result is consistent with Jimoyiannis (2010) who found that the restrictions posed for instructional practices by the science textbooks were one of the difficulties to integrate ICT in science classrooms.

Lack of professional development is another obstacle that hinders the use of ICT in teaching. Similar results were observed in other research studies regarding the need of professional development programs (Aytekin et al., 2012; Gurcay, Wong, & Chai, 2013; Forgasz, 2006).

Unavailability of suitable software and hardware for teachers to use ICT in teaching also acts as a barrier. This result is consistent with Brush et al. (2008) who found that the lack of software in schools was a barrier that affected pre-service teachers' use of ICT in teaching.

In turn, the internal barrier that impacted teachers' use of ICT in the classroom was difficulty to use ICT in teaching. It was one of the internal barriers that hindered teachers from using ICT in the classroom. This result is consistent with Koc and Bakir (2010) who found that it was easy for the pre-service teachers to use computers as tutorial tools in the classroom, but it was difficult for the pre-service teachers to use computers to engage their students in higher order thinking. Negative peer pressure was minor as few teachers mentioned its impact on their use of ICT in teaching. Negative attitude was the least impactful barrier that influenced ICT integration into the curriculum. This result is consistent with Ertmer (2012) who found that participating teachers' attitudes were the least barrier that influenced their use of technology in the classroom.

Pedagogical belief was another internal barrier that influenced teachers' use of ICT in the classroom. Teachers of the current study stated that teaching science is not limited to the use of technology; there are different teaching approaches that can be used in the classroom to teach science. This was affirmed by Ertmer and Ottenbreit-Leftwich (2009) who suggested that teachers' pedagogical beliefs influence teachers' use of technology in the classroom. Teachers typically attempt to use pedagogical approaches that are relevant to their goals (Ertmer & Ottenbreit-Leftwich, 2009Lim & Khine, 2006). Moreover, teachers' vision of themselves as pedagogical experts (Remond & Lock, 2013) influences their choices of which approach they should use in the classroom, especially when these approaches work adequately (Ward & Parr, 2010).

7.2.2 Incentives

The results of the interviews showed that there were two types of incentives that encouraged teachers to use ICT in the classroom: external incentives, and internal incentives. The external incentives were: 1) availability of resources and information, 2) availability of technical support, 3) availability of technology, 4) experience in using computers, 5) fewer tasks, 6) students' numbers in the classroom, and 7) support from school administrators. While, the internal incentives were: 1) ease of use, 2) positive attitudes, 3) positive intention, 4) positive peer pressure, and 5) usefulness.

In regard to the external incentives, support from school administrators was the major enabler that motivated teachers to use ICT in teaching. Teachers see the support from principal or head of department as an important motivator that can increase their use of ICT in the classroom. This could be attributed to the role technology plays in affecting the results of teachers' progress reports which affect their promotion. Similar results about the importance of support from school were demonstrated by previous research (Al-Awidi & Alghazo, 2010; Forgasz, 2006; Wood et al., 2005).

Availability of technology is the second major incentive that encourages teachers to use ICT in teaching. The existence of technology such as computers, LCD projectors, and interactive white boards seemed the main requirements to integrate ICT in the classroom. Similar results were found by Forgasz (2006) who found that availability of computers was the second highest enabler that enabled teachers to use ICT in the classroom.

Availability of resources and information for teachers to use ICT in teaching is another external incentive that encourages teachers to use ICT in teaching. This result is consistent with Martinovic and Zhang (2012) who suggested that the availability of the educational resources is beneficial for successful and sustained use of ICT in teaching.

Experience in using computers is also another external enabler that enables teachers to use ICT in teaching. This result is consistent with previous research findings in that teachers' skill and experience in using ICT are important incentives that motivate teachers to use ICT in teaching (Agyei & Voogt, 2010; Al-Awidi & Alghazo, 2012; Govender & Govender, 2009; Forgasz, 2006).

With regard to the internal enablers, usefulness is the major internal enabler that encourages teachers to use ICT in teaching. The positive outcomes from using ICT in teaching in improving the learning and teaching process motivate teachers to use ICT in their classrooms. This result is consistent with previous research studies that found that perceived usefulness contributed the most to the discriminating function for teachers (Mueller, Wood, Willoughby, & Ross, 2008; Pynoo et al., 2011; Teo & Schaik, 2012).

Positive attitude is the second major enabler that enables teachers to use ICT in the classroom. The result of the current study indicated that most teachers have positive attitudes toward using ICT in teaching except one teacher, who attributed her negative attitude to the low results that she got in her annual report despite her use of technology in teaching. The result of the current study is consistent with previous research studies that demonstrated that most of the teachers have positive attitudes toward ICT integration into classroom (Drent & Meelissen, 2008; Mueller, 2008; Teo, 2011; Chien, Kao, Yeh, & Lin, 2012; Zhou, Hu, and Gao, 2010). Moreover, the result of the current study is consistent with Alayyar, Fisser, and Voogt (2012) who found that most of the Kuwaiti pre-service science teachers had positive attitudes toward using ICT in teaching.

Positive peer pressure is another important internal incentive that helped in enabling the teachers to use ICT in teaching. The encouragement of the principal, head of department, or supervisor gave the motivation to the teachers to use ICT in teaching. This is consistent with Pelgrum and Voogt (2009) who found that the encouragement of the school leaders played an important role on teachers' choice of using ICT in teaching and learning. Moreover, Pierce and Ball (2009) demonstrated that teachers felt that the school leaders expected them to use technology in the classroom and this motivated teachers to use technology in the classroom to enhance the students' learning. The teachers in the current study were also rewarded because they used ICT in teaching; also they were given high marks in their annual report assessment due to their use of ICT in the classroom. These rewards motivated teachers to use ICT more. This is inconsistent with Muller et al. (2008) who attributed the non-significant difference between high and low integration groups in terms of outward motivation for their work to the lack of external rewards for teachers who used technology more in their classes. Moreover, Lai and Chen (2011) demonstrated that school support alone is not enough for teachers to be motivated to use blogs in teaching; extrinsic reward plays an important role in motivating teachers to use blogs in teaching. Lai and Chen (2011) attributed the insignificant relationship between school support and adoption of teaching blogs to the lack of rewards for the efforts expended by teachers.

Ease of using ICT in teaching was an important internal catalyst for the integration of ICT in teaching. The ease of using technology saved teachers' time and effort in the classroom and was a prerequisite for the successful integration of ICT into the teaching. This result is consistent with Bennett, Lockyer, and Brown (2005) who indicated that the teachers they studied were comfortable with using computers in the classroom which in turn helped them in using digital resources in teaching.

Positive intention was another internal enabler that motivated teachers to use ICT in teaching. Positive intention regarding the use of ICT reflected internal stimulation to use ICT in teaching in future. This result is consistent with a previous study that was conducted by Anderson and Maninger (2007), who found, after the pre-service teachers completed a course about using educational technology for instructional purposes, increases in the pre-service teachers' intentions to use computers in their future teaching. These increases demonstrated that the intention to use computers in teaching was an important factor that worked as a catalyst for the integration of computers.

7.2.3 Subjective Norms

The results of the interviews indicated that most of the teachers were affected by the subjective norms. The subjective norms were in descending order: 1) student; 2) principal; 3) head of department; 4) teacher; 5) supervisor; 6) colleague; and 7) school administration. The results of the current study indicated that other people's opinions regarding the use of ICT in teaching played an important role in enhancing teachers' use of ICT in teaching. These results are consistent with previous research studies (Mulken, 2003; Teo, 2010b;Yuen & Ma, 2008).

Also, the current study demonstrated that the most important subjective norm according to the science teachers was the student. Enhancing the students' achievement was one of the main reasons for teachers to use ICT in teaching. This was affirmed by Martinovic and Zhang (2012) who found that teachers seemed to have students' interest as a priority and attempted always to use all the tools and technology to draw students' attention. It seems from this result that most of the teachers hold a learner-centred belief which concurs with previous study where similar belief has been associated (Liu, 2011).

7.2.4 Use of ICT

There were three types of frequency regarding the level of ICT use in the classroom. These were: 1) teachers who always use ICT, 2) teachers with average use, and 3) teachers who did not use ICT. The results of the current study indicated that the frequency of use of ICT by teachers in the classroom was varied but all teachers used student-centred approaches. All the teachers emphasized their use of different teaching approaches to draw student attention and increase their academic achievement. This is inconsistent with Tondeur et al. (2008) who found that the teachers who did not integrate technology into the classroom did not use student-centred approaches.

Also, the result of the current study is inconsistent with previous studies that were conducted in the Middle East. Generally, Wiseman and Anderson (2012) demonstrated that teachers in the Gulf Cooperation Council (GCC) countries were still defined by teacher-centred approaches. Particularly, Alayyar et al. (2012) indicated that traditional teaching methods with teacher-centred approaches were still used by Kuwaiti teachers.

Moreover, the results of the interviews demonstrated that there were two types of ICT uses: use of ICT in the classroom, and use of ICT outside the classroom. The results reported that primary science teachers were frequently using ICT inside the classroom teaching despite the barriers (see section 7.2.1) that hinder science teachers from using ICT. This may be attributed to the role that technology plays in some subjects such as science and maths (Martinovic & Zhang, 2012). These results are different from results of the previous research studies which found that the use of ICT was limited in the classroom (Al-Amoush et al., 2013; Judson, 2006; Liu, 2011; Wood et al, 2005). Few studies demonstrated average use of ICT in teaching (Ottenbreit-Leftwich et al., 2010; Project Tomorrow, 2010; Umar & Yusoff, 2014). Most of the previous research studies found that the use of ICT was for supportive uses such as communication (CD-G, 2006; Kafyulilo & Keengwe, 2013; Ward & Parr, 2010;). The previous studies mentioned above found that ICT plays a supportive role in teaching. Whereas this study demonstrates that ICT have an instructive role in teaching practice. In other words, this study shows that the teachers use ICT not only for communicating with others or posting videos and new ideas (supportive practices), but also integrating ICT in teaching science to improve the student achievement (instructive practices). Teachers have the courage to use ICT in teaching due to its importance in enhancing the learning and teaching process (Prestridge, 2012). Moreover, teachers use ICT in teaching because they are nowadays more open to ICT-enhanced learning (Barak, 2014).

According to the differences in ICT usage between teachers, Mueller et al. (2008) demonstrated that experience with technology and attitudes toward using technology were important factors that predicted differences between teachers who fully integrated computers and teachers with limited integration. This was confirmed by the current study as teachers who did not use ICT in teaching indicated that the lack of experience and negative attitudes were one of the factors that hindered them from using ICT in teaching compared to teachers who always used ICT in teaching.

7.2.4.1 Use of ICT in the classroom

The results of the current study indicated that the science teachers used Excel, Internet, PowerPoint, Word processer, and YouTube in the classroom to create teaching materials. Teachers used Excel to enter student records to observe student improvement. This result is consistent with Ottenbreit-Leftwich et al. (2010) who demonstrated that the teachers used grading programs to facilitate management of student records.

Also, the current study indicated that the teachers used the Internet and different websites to find information for the lesson. Teachers found a lot of information on the Internet through Google, online forums, and other websites that helped them in providing teaching resources. Similar results were found by Bennett, Lockyer, and Brown (2005), Ottenbreit-Leftwich et al. (2010), and Umar and Yusoff (2014) who demonstrated that the teachers used the Internet to search topics they were teaching. Umar and Yusoff (2014) attributed teachers' frequent use of Internet to the fact that Internet has been introduced for more than three decades ago, which make no surprise that the teachers are able to use it to search for information.

Moreover, the current study demonstrated that the teachers used YouTube to download educational videos and teaching materials to use them in the classroom to facilitate student learning and increase student knowledge. Similar results were demonstrated by Ottenbreit-Leftwich et al. (2010) who indicated the importance of videos for science teachers to explain scientific concepts for students to enhance their understanding. However, different results were found by Bennett et al. (2005) who indicated that none of the teachers downloaded resources to integrate them into their teaching. The results of the current study indicated that most of the teachers were confident in using technology such as YouTube, and Internet.

In addition, this study demonstrated that the teachers used PowerPoint to represent new topics in attractive ways to increase student understanding. Similar results were demonstrated by Ottenbreit-Leftwich et al. (2010) who indicated that teachers used PowerPoint to represent concepts visually to improve student comprehension and promote higher-level thinking.

The results of the current study are consistent with previous research regarding the discipline-specific uses of technology in science classrooms. Osborne and Hennessy (2003) indicated that to integrate ICT in the science classroom teachers should use the main forms of ICT which are relevant to science activity including tools for data capture (e.g. Excel), multimedia software (e.g CD ROMs, and DVDs), information systems (e.g. Internet), publishing and presentation tools (e.g word processing, and presentation tools), and computer projection technology (e.g. TV, and data project & screen). Moreover, SH and Shinde (2013) indicated that ICT software resources and software applications are important to increase the students' attention span, and provide opportunities for teachers to be creative in their teaching and in students' learning. In addition, they offered some of the technologies that can be used to integrate ICT in science classrooms such as using a word processer to construct worksheets; Excel to provide a framework for the collection of data; PowerPoint to provide video images, animations, and clips; CD-ROMs to store a vast amount of information; virtual experiments to tabulate data arising from the experiment and generate an appropriate graph from it; Internet to search for information using up to date search engines such as YouTube, Yahoo, and Google to produce best results (SH & Shinde, 2013). According to the findings of the current study science teachers implemented these technologies in their science classes, which demonstrated that the science teachers were aware of the importance of these technologies to enhance science teaching and learning.

7.2.4.2 Use of ICT outside the classroom

Teachers used technology not only in the classroom, but also outside the classroom for educational purposes. These uses of ICT were: posting pictures and videos, communicating with others (such as students, parents, colleagues, and head of department), and sharing ideas. The availability of smart phones has made it easy for teachers to communicate, share ideas, and find information. Previously, teachers were compelled to use computers to do such activities which was difficult due to the need to carry the computer all the time. On the other hand, the smart phones are easy to carry and use. The results of the current study demonstrated the use of the smart phones for educational purposes. All teachers had smart phones and the majority of them benefited from the applications that existed in their phones such as WhatsApp, Instagram, and Internet to accomplish their educational tasks. For example, the teachers used WhatsApp to communicate with colleagues and the head of department, share ideas, and upload information. Moreover, the teachers used Instagram to post educational pictures and videos, and communicate with teachers, parents, and students. The results of the current study are consistent with Norris, Hossain, and Soloway (2011) who found that the teachers used smartphones outside the classroom for web searches; sharing information with families, children, and colleagues; and watching educational videos. Moreover, Norris, Hossain, and Soloway (2011) indicated that the teachers did not use these devices in the classroom because they were not allowed to use phones during the lesson, which is the same in Kuwait. According to the results of the current study, it was a good effort from the science teachers to use their smartphones for educational purposes. These uses of technology demonstrate the teachers have the willingness and enthusiasm to use technology to improve the science learning and teaching wether inside or outside the classroom.

7.3 Comparative analysis

The analysis of the questionnaire identified the factors that affected teachers' use of ICT and the causal relationships between these factors. The analysis of the interviews provided greater detail about why teachers make an effort to use ICT even if it is not provided by the schools. The results of the interviews support and confirm the results of the questionnaire which is consistent with the findings from the model. The results are as follows:

The factors identified during the qualitative analysis are similar to the factors identified in the quantitative analysis. These factors indicate synergies among science teachers' perceptions about the barriers and incentives for using ICT in teaching. The synergistic perceptions about the factors affecting teachers' use of ICT in teaching reflected the aspirations of science teachers' use of ICT for increased student achievement, enhanced teaching performance, enjoyment during the lesson, and saving time and effort.

Also, the results of the interviews confirm and support the results of the questionnaire regarding teachers' perceptions about the importance of the construct of perceived usefulness of ICT in teaching. Teachers' statements in the interviews show that perceived usefulness is the greatest predictor of ICT acceptance, which was similar to the result of the questionnaire. Moreover, the questionnaire indicated that there was no relationship between perceived external barriers and all the other factors, despite the existence of the external barriers. The results of the interviews found the reason behind this insignificant relationship; teachers work hard to overcome the barriers that hinder them from using ICT in teaching by providing their own laptops, LCD projectors, and Internet.

The results of the interviews support the results of the questionnaire regarding the significant relationship between subjective norms and teachers' attitudes toward using ICT in teaching. Teachers emphasized the effect of the positive opinions of the principal, supervisor, head of department, or students about using ICT in teaching on enhancing their attitudes toward the integration of ICT in teaching.

Overall, the results demonstrated that science teachers are not only ready to use ICT in teaching, but also have the awareness about the benefits of using ICT for teaching and learning process. Similar results were found by Martinovic and Zhang (2012) who indicated that pre-service teachers seriously sought opportunities to use different kinds of ICT in their classes, because they understood its importance to promote students' achievement. Based on the reliability and validity of the model and the support from the interview data, the current study proposes a guiding framework that can guide the Ministry of Education for the successful integration of ICT in teaching science.

7.4 Strategies for successful ICT implementation

The results indicated that teachers are willing to use ICT in teaching. Based on the evidence drawn from the findings this research suggests some important strategies to attempt to overcome the barriers that were identified through this research and that can help schools to integrate ICT as an integral part of their curriculum

Strategies for successful implementation of ICT in teaching science:

- Provide computers, LCD projectors, LCD projector screens, and interactive boards in classrooms and in science laboratories for all primary schools. It will remove the barrier of teachers' access to technology
- Provide syllabuses that are designed to integrate Information and Communication Technology, and provide all the materials and resources that are required to integrate ICT within the science curriculum. Also, the ministry of education in Kuwait provides a large curriculum with too much information. Some extended topics can be reduced without distorting the curriculum. Reducing the science curriculum provides more time for science teachers to teach and benefit from using ICT in teaching science. This solution is unique for the current study and has not been seen in any other previous research studies to the knowledge of the researcher.
- Assign to the assistant, who has the task of preparing the laboratory for science teachers, an additional task that is preparing the computers for the teachers prior to their attendance to their classes to provide more time for actual teaching practice as time constraints and time taken to set up the technology within constrained time was identified as one of the main barriers in the adoption of ICT as a teaching tool by the teachers. This solution is also unique for the current study and has not been seen in any other previous research studies to the knowledge of researcher.
- Reduce the unimportant preparations of graduation ceremonies, morning assemblies, workshops, and competitions; and waste of time, money and effort for presenting such activities and celebrations; and encourage schools to make these kinds of activities and celebrations as simple as possible. It will remove the barrier of additional tasks assigned to teachers. This solution is also unique for the current study.
- There should be a shared vision in school, which means that all the school together should work and help towards the success of using ICT in teaching such as providing lesson plans that integrate ICT (Hew & Brush, 2007). It will save teachers' time and provide extra support for them to successfully integrate ICT in teaching as lack of time and lack of support were identified as one of the barriers that influence teachers' use of ICT in the classroom.
- Collaborations between all the departments in the school can help in duplication of effort and in spending less time to prepare ICT-integrated plans or provide software. For example, some software applications that are created for one subject can be used for another (Martinovic & Zhang, 2012). This will help in removing the barrier of the long time spent in preparing ICT integrated plans.
- Reward and support teachers for using ICT effectively in the classroom which in turn will motivate other teachers to use ICT in their classroom. It will remove the barrier of some teachers' negative attitude toward using ICT in teaching.

Moreover, this study helped establishing new recommendations that build on a theoretical framework that helps the Ministry of Education to provide the best solution for ICT integration as shown in Figure 7.1.

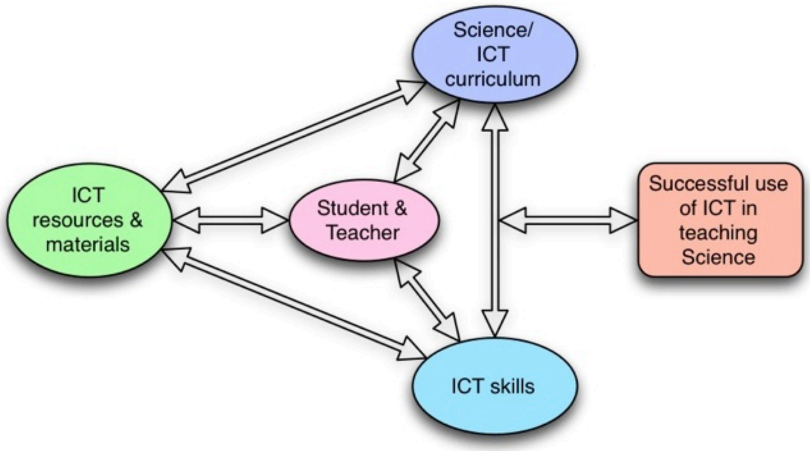


Figure 7.1: Guiding framework for ICT integration in science education

The finding of this study shows that the lack of the equipment, resources and Internet are the main barriers of ICT integration. Figure 7.1 shows the guiding framework that guides the ministry of education to implement ICT in teaching science. According to the results of current research study, this framework consists of providing a science curriculum that is designed to be taught using ICT, providing professional development programs that help train teachers how to teach the science/ICT curriculum, and provide all the materials (teaching plans,) and resources (computers, Internet, software and hardware). Both teachers and students are central in this successful implementation.

Teachers should be provided with the ICT/science curriculum and all the information required to easily using it in the classroom. They also should have skills and knowledge about how to use this ICT integrated curriculum, so they should be given workshops that could be conducted within school and provide all the materials that are needed for these workshops to be successful. Moreover, teachers should be supplied with resources (such as computers, LCD Projectors, interactive white boards, Internet, teaching materials, software and hardware) that are the main aspects of integrating ICT into the curriculum.

In turn, students should be prepared to be ICT skilled so they can use it for doing experiments, presenting projects, and communicating with teachers and each other. Also, students need to be given all information about the subject and how ICT will be integrated into the science curriculum. Moreover, they should be provided with materials and resources (e.g. Internet, computers, hardware and software, and educational websites) to allow them to use ICT properly.

Most of the teachers have positive attitudes and beliefs. They have the confidence in using ICT in teaching. Moreover, they get the support from the principal, colleagues, students, head of department, and supervisors. In their opinion the benefits of using ICT in teaching are invaluable, what they require is the formal inclusion of ICT in the syllabus and provision of resources required to adopt ICT as a tool for teaching. The recommendations given will help the Ministry of Education to successfully formalize and integrate technology in the curriculum and facilitate the implementation of ICT in the teaching practice.

7.5 Recommendations for future research studies

The current study provides opportunities for future research in regard to ICT integration. However, there is still need for more research that has not been covered by this research. For instance, the sample size of science teachers should be larger to develop a better understanding of teachers' perceptions regarding ICT integration in teaching. Also, classroom observations should be employed to gain deeper understanding of the classroom ICT practices which was not attempted in this research. As part of the further work, an analysis of student perceptions and acceptable of ICT could be considered. The use of artefact and analysis and student voice could be explored to determine the effect of ICT on student motivation and achievement.

ICT integration in Kuwait offers tremendous research opportunities as there has been little research on the use of ICT in teaching in Kuwait. The proposed model can be applied or adapted by adding new variables to the model to predict different teachers' use of ICT in teaching. This will provide a detailed understanding of the factors that affect teachers' use of ICT in different subjects. In addition, there could be applications of this model in different contexts, other countries and distinct cultural circumstances.

In addition, it would be interesting to study the ability of the proposed model in predicting the factors affecting teachers' use of ICT in different contexts. Also, cross-nation comparison studies can be conducted to attain deeper understanding of ICT adoption in different cultural contexts.

Moreover, the school issues of cooperation and networking need more research. Future research efforts should also explore principals' perceptions of what is involved in hindering or enabling teachers to use ICT in teaching.

7.6 Contribution of the research

This study has made a significant contribution to the research on ICT integration and to the theoretical body of knowledge for acceptance of ICT in Kuwaiti educational environment. Its contribution to theory is substantial as the research developed a new model that can predict science teachers' use of ICT in teaching. The research adapted the technology acceptance model (TAM) by adding new variables to the model to identify the factors that affect teachers' use of ICT and to study the causal relationships between these variables that have not been researched previously in the context of teaching science using ICT.

Methodologically, the research involved a mixed method approach that consisted of surveys and interviews to enable the researcher to gain more in depth information about the factors that affect the integration of ICT in science classrooms and to provide the basis for triangulating the interviews findings with the survey findings. Also, previously the questionnaire has been translated into another language and the study contributes to the research in the Arab world as this questionnaire can be used by other researchers to conduct similar studies in different Arabic speaking countries.

The research therefore, made a significant contribution to the theory of theoretical framework of study in Kuwaiti classrooms for the factors that influence the use of ICT. This is the first study of primary science teachers' actual use of ICT, the factors emerging from teachers' perceptions that could impact the way ICT is used in the classroom and the causal relationship between these factors.

The research contributes to policy and practice in Kuwait education as well as the wider Arabic education sector. Taking these new theoretical factors into account, it provides a guiding framework to the Kuwaiti Ministry of Education for effectively integrating ICT in primary science education. The framework represents the main requirements for successful ICT integration in classrooms. The framework could be adapted for other educational institutions in Kuwait and elsewhere.

Therefore the findings of this study could be of great significance in facilitating change at policy level to improve the ICT learning and teaching skills among the science teachers and primary school students. The findings and recommendations of this research are expected to be particularly beneficial to educators, teachers, policy-makers, and Ministry of Education, in terms of the factors that require careful attention to successfully integrating ICT in the classroom. Although the study was limited to Kuwait primary schools, it is expected that the findings can be applied in other educational institutions and a make contribution to the educational theory that supports ICT for teaching and learning.

7.7 Conclusion

The purpose of this research was to propose a model that can predict teachers' use of ICT in teaching by investigating the factors that affect teachers' use of ICT in teaching and the extent to which ICT is used in the classroom in Kuwait primary schools. Based on mixed methods approach, the analytical discourse of this research identified the factors that affect science teachers' actual use of ICT in the classroom.

The ability of the proposed Information and Communication Technology Acceptance Model (ICTAM) in predicting teachers' use of ICT in teaching was assessed using structural equation modelling. The results of the quantitative analysis confirmed that the proposed model (ICTAM) is valid and reliable to predict the science teachers' actual use of ICT in the teaching. The results of interviewing science teachers supported the results of the questionnaire regarding the factors that affect science teachers' use of ICT in teaching and provided a clearer picture about the factors affecting the integration of ICT and the extent of ICT usage.

The teachers had positive attitudes and beliefs regarding the use of ICT in the classroom. The use of ICT in the classroom was discerned as an instructive tool that could be affected by external barriers that may hinder teachers from using ICT in teaching. To address the challenges associated with the existence of these barriers the research provides recommendations to successfully integrate ICT in the classroom.

In this study, the science teachers are creative and are making smart decisions about when to use ICT in teaching; and they work hard to overcome the barriers that prevent them from using ICT in teaching by providing their own equipment (Ertmer et al., 2012). However, such uses are yet to reach the ultimate goal of engaging students in authentic problem-solving (Ertmer & Ottenbreit-Leftwich, 2013) due to the lack of effective and efficient tools. Therefore, future progress requires the Ministry of Education to provide a collaborative structure that engages teachers and students for successful ICT integration. The study provides a guiding framework that is suggested to create an opportunity for successful ICT usage that leads to enriching the teaching and learning process.

In conclusion, this study has developed, tested and implemented a model that reliably predicts the primary science teachers' acceptance of ICT. This model showed a causal relationship between the factors that affect the use of ICT in the classroom. The most significant factors in this model are perceived usefulness and ease of use. More confirmation for the validity of the proposed model was determined by interviews with 21 teachers and the analysis of the responses to the questionnaire about their use of ICT. The results of this study and the subsequent models have been used to build a theoretical framework for the integration of ICT in Kuwaiti primary schools.

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Appendix 1

Research Questionnaire

In this questionnaire you will be asked questions about your use of ICT (Information and Communication Technology). The term ICT refers to the use of the communication technologies such as Internet, and E-mail; and the use of computer software applications such as Word Processer, and PowerPoint. Remember all answers are completely confidential, so please feel free to be as open and honest as possible. Also, you are free to withdraw from the study at any time.

Demographic information:

1. Gender. ☐ Male ☐ Female

2. Age: ☐ 20-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 40-45 ☐ 46+

3. Number of years of teaching experience:

☐ Less than 1 year ☐ 1-5 years ☐ 6-10 years ☐ 11-15years ☐16-20 years ☐20+

4. Complete the statement using each ending phrase, and then circle the most appropriate choice.

Self-efficacy (se)

I feel confident that I could use ICT to:	strongly disagree				strongly agree
Evaluate appropriately students' activities and tasks.	1	2	3	4	5
Select and use educational software for a defined task according to quality, appropriateness, effectiveness, and efficiency.	1	2	3	4	5
Create project-based learning activities using a range of instructional strategies for individuals and small/whole groups.	1	2	3	4	5
Plan, select, and implement instruction that allows students to use ICT in problem-solving and decision-making situations.	1	2	3	4	5
Teach students how to locate, retrieve, and retain content-related information from a range of texts and technologies.	1	2	3	4	5
Perform administrative tasks such as taking attendance, maintaining grade books, and facilitating communication.	1	2	3	4	5
Create a lesson or unit that incorporates subject matter software as an integral part.	1	2	3	4	5

5. Complete the statement using each word, and then circle the most appropriate choice.

Subjective norms (sn)

My use of ICT in teaching would be influenced by:	strongly disagree				strongly agree
Principal	1	2	3	4	5
head of department	1	2	3	4	5
Colleague.	1	2	3	4	5
Supervisor.	1	2	3	4	5
Parent.	1	2	3	4	5
Student.	1	2	3	4	5

6. Do you agree with each of the following statements? Circle the most appropriate choice.

Perceived external barriers (peb)

The following external barriers will hinder me from teaching using ICT:	strongly disagree				strongly agree
Lack of resources (educational software).	1	2	3	4	5
Lack of professional development opportunities on using ICT in teaching.	1	2	3	4	5
Lack of access to the Internet.	1	2	3	4	5
There is not enough time in class to implement technology-based lessons.	1	2	3	4	5
Technology-integrated curriculum projects require too much preparation time.	1	2	3	4	5
Lack of technical support.	1	2	3	4	5
Lack of support from school administrators, parents, or other teachers.	1	2	3	4	5
Lack of technology-integration plan.	1	2	3	4	5
Lack of leadership.	1	2	3	4	5
Pressure of High-stakes examinations.	1	2	3	4	5
Lack of using ICT to measure student learning through high-stakes examinations.	1	2	3	4	5

7. Do you agree with each of the following statements? Circle the most appropriate choice.

Perceived Ease of use (peou)

	strongly disagree				strongly agree
Learning to use ICT in teaching is easy for me.	1	2	3	4	5
I find it easy to use ICT in teaching if I want to use it.	1	2	3	4	5
My interaction with ICT in teaching is clear and understandable.	1	2	3	4	5

I find using ICT in teaching enables more flexible interaction.	1	2	3	4	5
It is easy for me to become skilful at using ICT in teaching	1	2	3	4	5
I find ICT easy to use in my teaching.	1	2	3	4	5

8. Complete the statement using each ending phrase, and then circle the most appropriate choice.

Perceived usefulness (pu)

Using ICT in my teaching:	strongly disagree				strongly agree
Enables me to teach more quickly.	1	2	3	4	5
Improves my teaching performance.	1	2	3	4	5
Enhances my effectiveness in present teaching materials.	1	2	3	4	5
Makes lessons more motivating.	1	2	3	4	5
Helps students understand the lessons better.	1	2	3	4	5
Develops students' learning skills.	1	2	3	4	5

9. Do you agree with each of the following statements? Circle the most appropriate choice.

Attitude behaviour (ab)

	strongly disagree				strongly agree
Using ICT in teaching is interesting.	1	2	3	4	5
Using ICT in teaching is fun.	1	2	3	4	5
I like using ICT in teaching.	1	2	3	4	5
I look forward to those aspects of teaching that require me to use ICT	1	2	3	4	5
Once I get using ICT in teaching, I find hard to stop.	1	2	3	4	5

10. Do you agree with each of the following statements? Circle the most appropriate choice.

Intention (i)

	strongly disagree				strongly agree
I intend to use ICT in teaching when it becomes available in my school.	1	2	3	4	5
I intend to use ICT in teaching as often as possible.	1	2	3	4	5
I intend to use ICT in teaching on a regular basis in the future.	1	2	3	4	5
I intend to recommend strongly to others to use ICT in teaching.	1	2	3	4	5
I intend to use ICT in teaching in future.	1	2	3	4	5
I intend to use ICT in teaching often.	1	2	3	4	5

11. Please indicate the frequency of your use of ICT in teaching. Circle the most appropriate choice.
Please make sure that your answers reflect your use of ICT the last six months.

Behaviour (b)

How many lessons did you use ICT in your teaching in the week 1&2?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons
How many lessons did you use ICT in your teaching in the week 3&4?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons
How many lessons did you use ICT in your teaching in the week 5&6?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons
How many lessons did you use ICT in your teaching in the week 7&8?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons
How many lessons did you use ICT in your teaching in the week 9&10?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons
How many lessons did you use ICT in your teaching in the week 11&12?	Did not use	1 lesson	2-5 lessons	6-9 lessons	10+ lessons

Thank you

Appendix 2

(Study questionnaire in Arabic translation)

استبيان البحث

في هذا الاستبيان ستوجه اليك أسئلة حول استخدام ت.م.أ (تكنولوجيا المعلومات والاتصالات) حيث يشير المصطلح ت.م.أ الى استخدام تكنولوجيا المعلومات والاتصالات مثل الانترنت والبريد الالكتروني واستخدام تطبيقات برامج الحاسب مثل منسق الكلمات و برنامج العروض البوربوينت. نذكر ان الاجابات بالكامل سرية لذا يرجى التكرم بأ ن تجيب صراحة وامانة على قدر الامكان. كذلك انت حر في الانسحاب بأي وقت.

المعلومات السكانية :

1.الجنس ☐ ذكر ☐ انثى

2.العمر ☐ 20 25 ☐ 26 30 ☐ 31 35 ☐ 36 40 ☐ 41 45 ☐ +46

3.عدد سنوات الخبرة في التدريس:

☐ اقل من سنة واحدة ☐ 1 5 سنة ☐ 6 10 سنة ☐ 11 15 سنة ☐ 16 20 سنة ☐ +21 سنة

4.أكمل الافادة بجملة ختامية وبعد ذلك ضع دائرة حول الاجابة الاكثر ملائمة:

أشعر بثقة لاني استطيع ان استخدم ت.م.أ في :	لا أوافق بشدة				أوافق بشدة
تقييم انشطة وواجبات الطلاب بطريقة مناسبة	1	2	3	4	5
اختيار واستخدام البرنامج التعليمي للمهام المحددة من حيث الجودة والملائمة والفعالية والكفاءة	1	2	3	4	5
انشاء مشروع على اساس التعليم باستخدام مجموعة من الاستراتيجيات التعليمية للاشخاص والمجموعات الصغيرة أو المجموعات بالكامل.	1	2	3	4	5
التخطيط واختيار وتفسير التعليم الذي يسمح للطلاب باستخدام ت.م.أ في حل المشاكل ومواقف اتخاذ القرار.	1	2	3	4	5
تعليم الطلاب كيفية تحديد واسترجاع والاحتفاظ بمحتوى المعلومات من مجموعة النصوص والتكنولوجيات.	1	2	3	4	5
تنفيذ المهام الادارية مثل عمل حصر الغياب والاحتفاظ بدفاتر الدرجات وتسهيل الاتصالات.	1	2	3	4	5
عمل درس او وحدة يتضمن برنامج عن الموضوع بحيث يكون جزء لايتجزأ منه	1	2	3	4	5

5.اكمل الافادة باستخدام الكلمة المناسبة عن طريق وضع دائرة حول الاختيار المناسب:

استخدمي ت.م.أ قد يتأثر بما يلي :	لا أوافق بشدة				أوافق بشدة

الناظر	1	2	3	4	5
رئيس القسم	1	2	3	4	5
الزميل	1	2	3	4	5
الموجه	1	2	3	4	5
اولياءالامور	1	2	3	4	5
الطلاب	1	2	3	4	5

6.هل توافق على الافادات التالية؟ ضع دائرة على الاختيار المناسب:

العوائق الخارجيه التالية سوف تعوقني عن استخدام ت.م.أ :	لا أوافق بشدة				أوافق بشدة
الافتقار للمصادر (البرامج التعليمية)	1	2	3	4	5
الافتقار لفرص التطوير المهني في استخدام ت.م.أ في التعليم.	1	2	3	4	5
عدم وجود انترنت	1	2	3	4	5
لايوجد وقت كافي في الصف لتطبيق التكنولوجيا في تعليم الدروس.	1	2	3	4	5
مشاريع مناهج التكنولوجيا الكاملة تحتاج وقت كبير جدا للاعداد.	1	2	3	4	5
الافتقار للدعم الفني	1	2	3	4	5
الافتقار لدعم ادارة المدرسة، اولياء الامور، المدرسين وغيرهم.	1	2	3	4	5
الافتقار لمخطط التعليم المتكامل	1	2	3	4	5
غياب القيادة	1	2	3	4	5
ضغط الامتحانات العالي التوتر	1	2	3	4	5
الافتقار لاستخدام ت.م.أ كمعيار لتعليم الطالب من خلال الامتحانات العالية التوتر.	1	2	3	4	5

7.هل توافق على الافادات التالية؟ ضع دائرة حول الاختيار المناسب:

	لا أوافق بشدة				أوافق بشدة
استخدام ت.م.أ في التعليم سهل بالنسبة لي.	1	2	3	4	5
اجد الامر سهل في استخدام ت.م.أ في التعليم اذا رغبت في استخدامه.	1	2	3	4	5
تفاعلي مع ت.م.أ في التدريس واضح ومفهوم.	1	2	3	4	5
اجد ان استخدام ت.م.أ في التدريس يمكنني من التفاعل بمرونة.	1	2	3	4	5
من السهل ان اصبح ماهر في استخدام ت.م.أ في التدريس.	1	2	3	4	5
أجد ان ت.م.أ سهله الاستخدام في التدريس	1	2	3	4	5

8. أكمل الافادة بجملة ختامية وبعد ذلك ضع دائرة حول الاختيار الاكثر ملائمة:

استخدام ت.م.أ اثناء تدريسي:	لا أوافق بشدة				أوافق بشدة

يساعدني في التعليم بسرعة	1	2	3	4	5
يحسن ادائي التدريسي.	1	2	3	4	5
يحسن من فاعليتي في تقديم المادة التعليمية.	1	2	3	4	5
يجعل الدروس اكثر حافزية	1	2	3	4	5
يساعد الطلاب في فهم الدروس بطريقة افضل.	1	2	3	4	5
يساعد على تطوير مهارات الطلاب التعليمية.	1	2	3	4	5

9.هل توافق على الافادات التالية؟ضع دائرة حول الاجابة الاكثر ملائمة:

	لا أوافق بشدة				أوافق بشدة
استخدام ت.م.أ في التدريس ممتع.	1	2	3	4	5
استخدام ت.م.أ في التدريس مسل.	1	2	3	4	5
احب استخدام ت.م.أ في التدريس.	1	2	3	4	5
اتطلع الى مظاهر تدريسية تتطلب مني استخدام ت.م.أ	1	2	3	4	5
بمجرد ان استخدم ت.م.ا في التدريس لن يمكنني التوقف.	1	2	3	4	5

10.هل توافق على الافادات التالية؟ ضع دائرة حول الاجابة الاكثر ملائمة:

	لا أوافق بشدة				أوافق بشدة
انوي استخدام ت.م.أ حينما تكون متاحة في مدرستي.	1	2	3	4	5
انوي استخدام ت.م.أ في التدريس عادة بقدر الامكان.	1	2	3	4	5
انوي استخدام ت.م.أ في التدريس بصورة منتظمة في المستقبل.	1	2	3	4	5
اوصي بشدة الاخرين باستخدام ت.م.أ في التدريس	1	2	3	4	5
انوي استخدام ت.م.أ في التدريس في المستقبل.	1	2	3	4	5
انوي استخدام ت.م.أ في التدريس عادة.	1	2	3	4	5

11.يرجى تحديد مرات استخدام ت.م.أ في التدريس. ضع دائرة حول الاختيار الاكثر ملائمة:

. يرجى التأكد من ان الاجابة توضح استخدامك ل ت.م.أ في الستة اشهر السابقة.

عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 1و2	لم استخدم	1 درس	5 2 درس	9 6 درس	10+ درس
عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 3و4	لم استخدم	1 درس	5 2 درس	9 6 درس	10+ درس
عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 5و6	لم استخدم	1	5 2	9 6	10+

		درس	درس	درس	درس
عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 7و8	لم استخدم	1 درس	5 2 درس	9 6 درس	10+ درس
عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 9و10	لم استخدم	1 درس	5 2 درس	9 6 درس	10+ درس
عدد الدروس التي استخدمت فيها ت.م.أ في التدريس في الاسبوع 11و12	لم استخدم	1 درس	5 2 درس	9 6 درس	10+ درس

شكرا

Appendix 3

Interview Questions Guide

1. **What is your name**?
2. **How old are you**?
3. **How many years of teaching experience have you got?**
4. **Do you have a laptop?**
5. **Is there computer in science laboratory?**
6. **Do you have Internet in your mobile or at home?**
7. **Is there Internet at school?**
8. **What are the computer-based technologies that you use in classroom?**
9. **What are the other technologies that you use in the classroom?**
10. **Is the use of the ICT taken into account in your annual assessment?**
11. **Does the school provide support to the use of ICT?**
12. **What are the barriers that prevent you from using ICT in teaching?**
13. **What are the incentives to use ICT in teaching?**
14. **Do you like using ICT in the classroom, and why?**
15. **Who do you think affect your use of ICT in teaching? Write in descending order.**
16. **How do you assess your use of ICT the last six months?**

Appendix 4

(Interview questions in Arabic translation)

اسئلة المقابلة

1. ماسمك؟
2. كم عمرك؟
3. كم عدد سنوات الخبرة في التدريس ؟
4. هل لديك لاب توب؟
5. هل هناك كمبيوتر في مختبر العلوم؟
6. هل لديك انترنت في هاتفك او في البيت؟
7. هل هناك انترنت في المدرسة؟
8. ماهي الاجهزة التكنولوجية المعتمدة باستخدامها على الكمبيوتر التي يتم استخدامها في الفصل؟
9. ماهي الاجهزة التكنولوجية الاخرئ التي يتم استخدامها في الفصل؟
10. هل استخدام تكنلوجيا المعلومات في الفصل يتم اخذه في الاعتبار في التقرير السنوي؟
11. هل المدرسة تقدم دعم للمدرسين لكي يستخدموا تكنولوجيا المعلومات والاتصالات؟
12. ماهي العوائق التي تعيق استخدامك لتكنولوجيا المعلومات والاتصالات في الفصل؟
13. ماهي المحفزات التي تحفز استخدامك لتكنولوجيا المعلومات والاتصالات في الفصل؟
14. هل تحب استخدام تكنولوجيا المعلومات والاتصالات في الفصل ، ولماذا؟
15. من من الاشخاص تعتقد انه يوثر على استخدامك لتكنولوجيا المعلومات والاتصالات في الفصل؟ عدد من الاكثر تأثيرا حتى الاقل تأثير
16. كيف تحدد استخدامك لتكنولوجيا المعلومات والاتصالات في الفصل خلال الستة اشهر السابقة؟