A Review of Technology Acceptance Studies in the Field of Education

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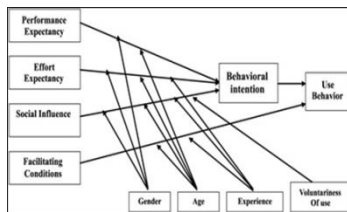
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Graphical abstract

Abstract

Technology acceptance studies are a common medium of determining approval and predicting future use of technologies in the field of Information Systems. Numerous technology acceptance studies have been done in the area of education however there still remain hindrances in the use of computer in education. The aim of this study is to analyse published research materials in the area of technology acceptance in education and identify the current research patterns. Upon identifying these patterns, a future research path is presented. For this purpose, initially the popular technology acceptance theories are studied so as to build a firm base for examining the technology acceptance works in education domain. The technology acceptance research works were thoroughly scrutinized to identify important aspects like acceptance theory used, constructs used, causal relationships and user types. Based on all these aspects a future research pathway is suggested.

Keywords: Computer based assessment; E-Assessment; technology acceptance; TAM; E-learning

■1.0 INTRODUCTION

The use of computers/Information Communication Technologies (ICT) in our lives has been ever increasing. Along with other areas their use in education has also gained popularity. In educational institutes computers are being used for a wide range of activities, i.e. from administrative tasks to imparting learning to the pupils. However, their acceptance and implementation in educational institutions has been limited due to many barriers and limitations [1, 2].

Understanding factors that affect a person's intent to use a system before the actual development of the system is important to make the system widely used and accepted by the future users. In the field of Information Systems, acceptance studies are often carried out to comprehend user intentions which consequently help in increasing system usage. These studies are also useful in designing and implementing a system with minimum issues [3-5]. Therefore, acceptance studies is the field of education is also required.

The point of this study is, to primarily analyze the prevalent theories in the field of technology acceptance in addition to analyzing past technology acceptance studies in education area. With this investigation, the aim is to bring forth the existing technology acceptance research pattern in education field, detect the limitations and suggest a future research path.

■2.0 METHODOLOGY

Research articles were searched in major databases like ScienceDirect, IEEE Xplore and Google Scholar using keywords e-assessment, e-learning, computer based assessment, advantages of e-assessment/e-learning, disadvantages of e-assessment/e-learning and their combinations to find out articles that explained the concept of e-assessment in depth.

Acceptance literature related to e-learning and e-assesment was also searched in the above mentioned databases. Keywords and their combinations used for this search comprised of – acceptance, e-assessment, computer based assessment, e-learning and acceptance theories. Only articles in which the acceptance methodology and analysis was clearly defined were selected. Majority of the articles selected have been published in renowned journals like Computers & Education and Computers in Human Behavior from 2002-2013. These selected articles were analyzed to identify the popular acceptance models used, the constructs used, user types and causal relationships.

■3.0 RESEARCH BACKGROUND

There are two main phases of pedagogy. One is imparting learning which is popularly known as teaching and the other being testing the knowledge, also known as examination.

In this section a concise background will be given about e-learning, e-assessment and the popular technology acceptance models. This background will help in understanding the other half of the paper in which the current acceptance research pattern in education area is explained.

3.1 Overview of the E-Learning Initiative

E-learning systems have been in use for quite some time now and hence a lot of popular definitions have cropped up from time to time. According to Wan *et al*., e-learning can be defined as "a virtual learning environment in which a learner's interactions with materials, peers and/or instructors are mediated through information and communication technologies" [6]. Morrison described e-learning as the accumulation of knowledge and skills through learning events and knowledge management sources which are written, conveyed, involved with, upheld and regulated utilizing web technologies. A common understanding that can be agreed upon from the above definitions is that e-learning is a type of learning in which all its processes are supported and delivered through the use of ICT [7].

The different e-learning techniques have been neatly classified by Horton *et al*. as per the following points [8]:

- Learning communities/blogs: they are online platforms that can be used to share knowledge and experience. This medium is very popular nowadays.
- Virtual classrooms/schools: this mode of education is primarily made possible through the use of video-conferencing and desktop sharing through the internet. This learning mode gives the benefit of location independence but still the students have to attend classes at fixed times.
- Web based systems: these are online knowledge repositories which can be used by the students at their own will. These may contain audio-visual materials, documents or simulators.
- Standalone Computer based systems: This is used of individual learning. The learning material is static and often cannot be upgraded. The material is usually provided on flash drives, CD and DVD.

E-learning has many advantages like, no time constrain for learning, freedom of location, personalized learning pace. This method has made learning more interactive and creative [9, 10].

The major difficulties in this mode of learning are that a high level of self-discipline and motivation required. Lack of a traditional classroom setup has also been found to be problematic with young children [9, 10].

3.2 Justifying E-Assessment

Often e-learning and e-assessment are considered to be one and the same thing, but it is not so. Assessment is used to measure learning to provide feedback (formative assessment) or it can be used for grading purposes (summative assessment). Whatever the purpose of assessment, it can be said that learning without assessment is impractical and vice versa. E-Assessment can be simply defined as, the use of ICT for the purpose of carrying assessment for gauging a student's learning [11, 12].

E-Assessment can be categorized according to different measuring parameters. It can be classified as formative and summative according to the purpose of examination. Formative assessment is used to provide feedback to the students, e.g. in class quiz, assignment whereas summative assessment is for grading purpose, e.g. semester exams [13].

It can be segregated as per the type of questions, into multiple choice questions, adaptive tests and open ended questions. In adaptive tests the difficulty level of questions is adapted as per the response of the user. In case of wrong response the difficulty level of the next questions is usually dropped. The most complex of these three types are open ended questions, as

evaluating them using computers is still a major challenge and an important area of research in the field of e-assessment [14-16].

E-Assessment can also be classified according to the type of technology used to conduct the examination. Optical Mark Recognition (OMR) sheets have become quite popular since the last decade. However, the use of dedicated scanners to read OMR sheets is an added financial and technical overhead. The other popular types are - E-Portfolios, standalone systems and network/web based systems. E-Portfolios give a wholesome assessment of the student as all the student's activities during the course lifetime is recorded in it. Standalone systems usually use some kind of external device to record the test output whereas in networked systems the output is usually saved on a server [13, 17, 18].

There are many advantages of e-assessment like quick evaluation of examinations, developing realistic questions utilizing audio-visual mediums, simulation etc. This type of examination can also be done for children with special needs. The major disadvantages are the high cost, security risks and technological failures [13, 19].

3.3 Popular Technology Acceptance Theories

To get a good understanding of technology acceptance studies it is essential that the theories or models that have been used to carry out these research works are known. Hence, in the following sub-sections, the popular technology acceptance models and theories are discussed.

3.3.1 Theory of Reasoned Action (TRA)

This is one of the oldest theories used for studying technology acceptance. It was developed by Fishbein and Ajzen in 1975. Majority of the technology acceptance models developed later on have been based on this theory. The commonly used construct Behavioural Intention (BI) which is used in many other technology acceptance models was a first introduced in this theory. As per TRA, an individual's intention is determined by their perception of what people close to him/her think about what behaviour he/she should display (Subjective Norm) and the individual's positive or negative emotional state towards the target behaviour (Attitude) [20]. Figure 1 shows the diagrammatic representation of the theory.
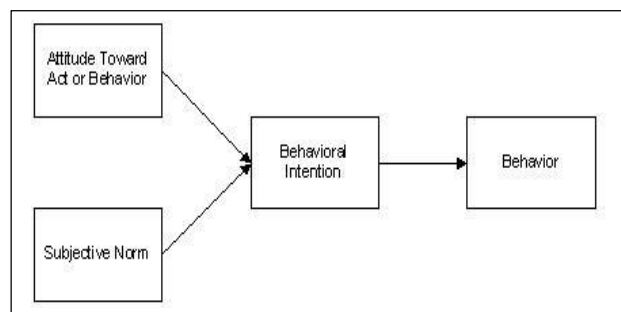

Figure 1 Theory of reasoned action

3.3.2 Social Cognitive Theory (SCT)

SCT was developed by Bandura in 1986. This was developed to understand the relationship between environmental effects and personal behaviour. The important construct self-efficacy that has been widely used in acceptance research was identified in this theory. As per Bandura self-efficacy can be defined as a person's verdict of their capabilities to arrange and implement ways of

action necessary to achieve selected types of performances. Self efficacy deals with how a person uses his/her skills in achieving a particular goal [6, 21].

3.3.3 Technology Acceptance Model (TAM)

This is the most popular technology acceptance model till date. It was formulated by Davis in 1989 by synthesizing it from TRA. Perceived Usefulness (PU) and Perceived Ease Of Use (PEOU) were introduced in this model. Davis defined PU as "the degree up to which a person believes that using a particular system would enhance his or her job performance" and PEOU was defined as "the degree up to which a person believes that using a particular system would be free of effort" [22]. The important relationships defined by this model are as follows:

- PEOU has direct effect on PU.
- Both PEOU and PU have an impact on Attitude towards using the system
- Attitude has direct impact on Behavioural Intention (BI) which consequently determines actual system use

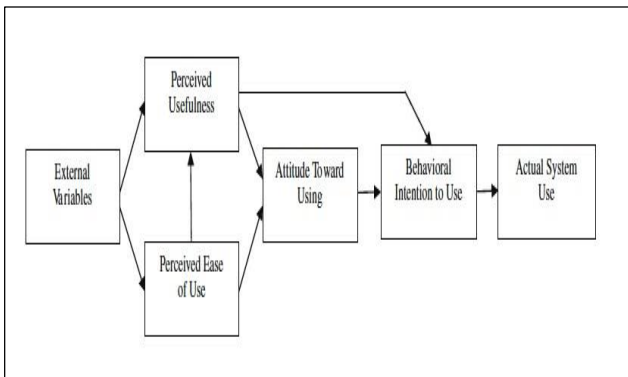The graphical representation of this model is presented in Figure 2.

Figure 2 Technology acceptance model

3.3.4 Theory of Planned Behavior (TPB)

This theory was developed by Ajzen in 1991 by extending Theory Of Reasoned Action (TRA) with a behaviour related construct based on the Bandura's Social Cognitive Theory (SCT).

In this the new construct Perceived Behavioural Control (PBC) has been defined as an individual's perception of the effort required to perform a particular behaviour [23].

In this the constructs Attitude, Subjective Norm (SN) and PBC are correlated. These three constructs have a direct impact on BI which in turn determines actual behaviour. The diagrammatic representation of the theory is given in Figure 3.
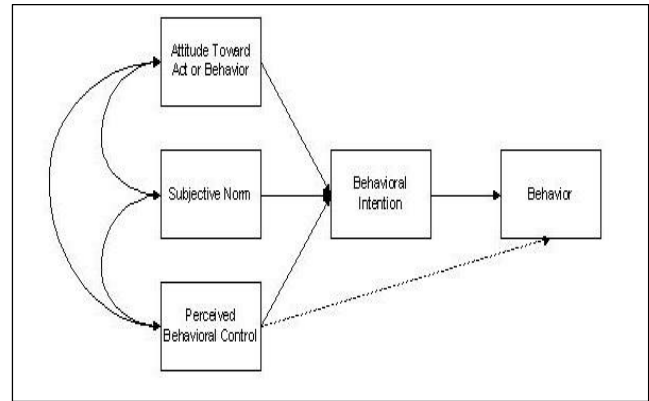

Figure 3 Theory of planned behaviour

3.3.5 Unified Theory of Acceptance and Use of Technology (UTAUT)

This theory was formulated in 2003 by Venkatesh and Davis. This model was made by extending TAM with constructs from other models like Technology Acceptance Model (TAM) [22]; Innovation Diffusion Theory (IDT) [24]; the Theory of Reasoned Action (TRA) [20]; the Theory of Planned Behaviour (TPB) [23]; the Combined TAM and TPB [25]; the Model of PC Utilization (MPCU) and Social Cognitive Theory [21].

In this theory three new variables, Performance Expectancy, Effort Expectancy, and Social Influence have a critical effect on Behavioural Intention (BI). Additionally construct Facilitating Conditions (FC) has a substantial impact on User Behaviour. Variables Gender, Age, Experience and Voluntariness Of Use moderate these relationships. The definitions of the major constructs are as follows:

- Effort Expectancy (EE): It describes how easy a system is to use.
- Facilitating Conditions (FC): It depicts the conviction of a user in the existing organizational infrastructure and support that encourages system use.
- Performance Expectancy (PE): The belief that using the system will increase job performance.
- Social Influence (SI): It defines how much is a user influenced by other people's belief in using a system.

Figure 4 shows the theory in the form of a relationship model.
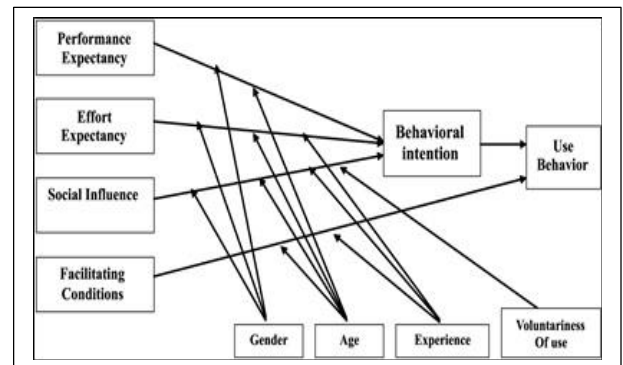

Figure 4 Unified theory of acceptance and use of technology

■**4.0 DISCUSSING PATTERNS IN CURRENT TECHNOLOGY ACCEPTANCE STUDIES IN EDUCATION**

In this section, the course of technology acceptance research in the field of education has been analysed and presented. As mentioned in the 'Methodology' section of this paper, thirty seven journal articles from 2002-2013 were examined to bring out various data related to the acceptance models used, the popular constructs and their relationships and user types.

4.1 Theories Used and User Types Studied

There have been many technology acceptance studies in the field of education, but a vast majority of them have been on the acceptance of e-learning. In the analysis of the previous literatures it was revealed that majority of the studies on e-learning acceptance have been done on students. Another important fact that was revealed was that most of these studies used TAM as the base model and extended it with other constructs. Very few studies used TAM without extending it. This can be well understood from Table 1.

On the forefront of e-assessment acceptance, just few research works have been done, the majority of the work has been done by Terzis *et al*. [13, 16, 26-28]. Two important points pertaining to studies on e-assessment acceptance are to be noted – one that the oldest research is only from 2011 and the other that all the studies have been on students and used TAM as base model. Table 2 will clarify the situation better. Analysing the models or theories used in acceptance studies on both e-assessment and e-learning shows that the most popular model is TAM. Nonetheless a common trend that was noted is that TAM was extended with constructs from other acceptance models and cognitive studies. In the area of e-assessment an acceptance model was developed by Terzis *et al*. [13] by extending TAM with constructs from Theory of Planned Behaviour (TPB) and UTAUT.

In Table 1 research pertaining to e-learning acceptance has been classified according to the user type and base acceptance theory used. The base acceptance theory is theory which was used as a base and then other constructs were added to it to expand it as per the context as of the study. '∑' represents the total number of studies.

Table 1 E-Learning studies

Technology Area	User Type	Base Model/Theory	Studies	∑
E-Learning	Student	TAM	[29-33]	5
		Extended TAM	[34-44]	11
		UTAUT	[45]	1
		TPB	[46]	1
		3-TUM	[47]	1
	Teachers	Extended TAM	[2,48,49]	3
		UTAUT	[50]	1
		D&M IS Success Model	[51]	1
		Theory of IS Continuance	[52]	1
	Pre-Service Teachers	TAM	[53]	1
		Extended TAM	[54,55]	2
	Student/Teachers	UTAUT	[3]	1
		3-TUM	[10]	1

Table 2 is similar to Table 1 except that it presents acceptance studies in the area of e-assessment.

Table 2 E-Assessment studies

Technology Area	User Type	Base Model/Theory	Studies	∑
E-Assessment	Student	Extended TAM	[13, 16, 26-28]	5

The use and acceptance of technology varies from user to user. A technology maybe popular and accepted by some user but it might not be with others. In the education domain the two main players are teachers and students, hence studying acceptance from both their perspectives is important. Previous research works have shown that teacher's use of technology is different from students and also their acceptance of technology in turn affects student's acceptance and use [2, 33, 56].

Many researchers have pointed out to the fact that TAM as a standalone model is not sufficient in explaining use and acceptance of technology. Researchers have also explained that constructs Perceived Ease of Use, Perceived Usefulness and Attitude might not sufficiently explain intention and use. This is one of the principal reasons for the development of different versions of TAM like TAM-2, TAM-3, UTAUT [2, 13, 37, 57].

From the points discussed in the above paragraphs and sub-section 3.1 the following arguments are apparent.

- Few research works have studied e-assessment acceptance
- Very few technology acceptance studies have been done on user type teachers
- TAM the most popular acceptance model has been extended most of the time while studying acceptance

4.2 Important Causal Relationships and Constructs

In this sub-section important constructs and their relationships have been identified and categorized. In Table 3 and Table 4 the most studied causal relationships observed in acceptance research relating to e-learning and e-assessment respectively has been noted down. '∑' represents the total number of studies in which the causal relationship has been studied. Some important constructs not discussed earlier in the 'Research Background' section will also be explained.

Table 3 Important causal relationship E-Learning

Technology Area	Causal Relationships	Studies	∑
E-Learning	PEOU to PU	[2, 29-31, 34-44, 48, 49, 51, 53-55, 58]	23
	PU to BI	[2, 30, 36, 40, 43, 47-49, 51, 54, 55, 58, 59]	13
	PU to AT	[34, 37, 41, 43, 48, 49, 53-55, 58]	10
	AT to BI	[37, 43, 45, 46, 48-50, 54, 55, 58]	10
	PEOU to AT	[34, 37, 41, 43, 48, 49, 53, 54]	9
	PEOU to BI	[30, 35, 36, 40, 42]	5
	CSE to PEOU	[2, 36, 39, 44, 45, 51]	6
	PEOU to U	[29, 37-39, 41, 44]	6
	FC to PEOU	[48, 54]	2
	SN to PU	[2, 38, 48, 49, 51]	5
	PU to U	[29, 38, 41, 44]	4
	SN to BI	[2, 48, 49, 51]	4
	AT to U	[46, 49, 50]	3
	CSE to PU	[31, 36, 54]	3
	CSE to BI	[2, 54, 59]	3

Perceived Ease Of Use (PEOU), Perceived Usefulness (PU), Behavioral Intention (BI), Attitude (AT), Computer Self Efficacy (CSE), Use (U), FC (Facilitating Condition), Subjective Norm (SN)

Table 4 Important causal relationship E-Assessment

Technology Area	Causal Relationship	Studies	Σ
E-Assessment	PP to BI	[16, 26, 27]	3
	PU to BI	[13]	1
	PU to PP	[16, 26, 27]	2
	PEOU to BI	[13, 16, 26, 27]	4
	PEOU to PU	[13, 16, 27]	3
	PEOU to PP	[13, 16, 26-28]	5
	CSE to PEOU	[13, 16, 26, 27]	4
	SI to PU	[16, 26, 27]	3
	FC to PEOU	[13, 16, 27]	3
	GE to PU	[13, 16, 27]	3
	GE to PP	[13, 16, 27]	3
	C to PU	[13, 16, 27]	3
	C to PP	[13, 16, 27]	3
	C to GE	[13, 16, 27]	3
	C to BI	[13, 16, 27]	3

Perceived Ease Of Use (PEOU), Perceived Usefulness (PU), Behavioral Intention (BI), Attitude (AT), Computer Self Efficacy (CSE), FC (Facilitating Condition), PP (Perceived Playfulness), SI (Social Influence), GE (Goal Expectancy), C(Content)

From the above discussed table it becomes very clear that most of the technology acceptance research has been in the area of e-learning while in e-assessment very few. Another point to be mentioned is that Deutsch *et al*., [18] in their e-assessment acceptance study didn't use any particular acceptance theory or model. A few constructs that were not explained earlier will now be described:

- Computer Self Efficacy (CSE): The construct Self-Efficacy was introduced in the Social Cognitive Theory (SCT) by Bandura. Later on, Computer Self Efficacy (CSE) was modelled based on Self-Efficacy by Compeau and Higgins in 1995. CSE can be defined as "The degree to which an individual beliefs that he or she has the ability to perform specific task/job using computer" [60]. Research has shown that CSE affects computer usage in education. A significant relationship between CSE and PEOU has also been established in many studies [13, 36, 54]. CSE explains a person's feeling about his/her computer competency.
- Perceived Playfulness (PP): Moon and Kim in their acceptance research work first introduced PP [61]. The explained PP will come into play if the user concentrates on the system, is curious about it and enjoys the system. In the analysis done in this study PP was found to be used only in e-assessment acceptance research.
- Goal Expectancy (GE): This construct was introduced in the e-assessment acceptance study by Terzis *et al*. [13]. They defined that GE will come into play when a user is satisfied with his/her preparedness to use a system and it will also depend on the desirable success level of the user with the system.
- Content (C): This construct was introduced by Wang [62] and this has only been used in e-assessment acceptance research. This construct explains that the content of an information system is also important for its success.

■**5.0 CONCLUSION AND FUTURE WORK**

In this research work, the acceptance of the two ICT enabled phases of education i.e. e-learning and e-assessment was discussed. In the starting, e-learning along with its different types, advantages and disadvantage was explained. The difference between e-assessment and e-learning was explained because they

are often thought as the same. Then the different types of e-assessments were discussed so as to show their variety. The pros and cons of e-assessment were also discussed. Since this review focuses on technology acceptance, hence, the various popular theories and models were also described.

Next, a detailed review of technology acceptance research in education area published in quality journals was presented. From the analysis of these studies many important patterns in the current research was found. It was found that the majority of the acceptance studies in education area have been on e-learning barring a few on e-assessment. Additionally another point to be noted is that the oldest research on e-assessment acceptance has only been done in the year 2011, hence showing a lack of research in this area. Therefore, more research is required in the area of e-assessment.

Most of the acceptance studies in e-learning concentrated on students whereas the few studies on e-assessment acceptance have all been done on user type students. As explained earlier acceptance varies according to user types; therefore acceptance research on user type teachers or lecturers is important and future studies need to be done.

Another research trend that was pointed out was that though most of the acceptance studies in education domain had used TAM but they had extended it with other relevant constructs. This shows that TAM is insufficient in explaining intention and use and other constructs should often be added while using TAM.

The causal relationship between the different constructs were also investigated and classified according to e-learning or e-assessment acceptance. Some rarely used constructs were explained.

This detailed review of technology acceptance in education can be of great help to future researchers as they can easily identify the popular constructs, causal relationships, user types studied and the education area in which technology acceptance has been studied. The information gathered in this study can be used for future technology acceptance studies in education domain. It can also be deduced from this work that e-assessment is the future of assessment and an area which has been left out by researchers; hence more research should be carried out in e-assessment field.

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