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Integration of ICT in Teaching and Learning: A Review of Theories

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Abstract. The integration of ICT in teaching and learning (IITL) brings about powerful learning environments and helps students to deal with knowledge in active, self-directed and constructive ways. Thus, all avenues to foster it should be explored. One such avenue is to isolate the factors underpinning IITL. In deriving these factors, several theories can be considered. This paper reviews six of these theories, namely, Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Technology-Organisation-Environment (TOE) framework, the Theory of Planned Behaviour (TPB), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technological Pedagogical Content Knowledge (TPACK) framework. The review is chronological. Though the paper may be of interest to researchers working on innovation adoption, it arose as part of a study on higher education.

Keywords: ICT; Pedagogy; Innovation adoption.

1 Introduction

Ghavifekr and Rosdy (2015) view ICT as a short hand for computers, software, networks, satellite links and related systems that allow people to access and share information and knowledge in a variety of forms. Hughes (2013) defines integration of technology in teaching and learning (IITL) as the use by teachers and/ or students of digital ICTs that support the constructivist teaching and learning process.

The significance of IITL is well captured by authors. For instance, Aktaruzzaman, Shamim and Clement (2011) assert that when used appropriately, different ICTs help in expanding access to education to the increasingly digital workplace through information distribution, learning management systems and managing of educational services and make them

affordable and available anytime and anywhere. For example, they argue that opportunities are now open to individuals and groups who were previously constrained from attending traditional universities to access higher education and other forms of adult learning through online modes of learning such as e-learning, blended learning among others.

Coleman, Gibson, Cotten, Howell-Moroney and Stringer (2016) contend that the appropriate use of ICT in teaching transforms the learning environment from teacher-centred to learner-centred. They stress that this shifting of emphasis from teaching to learning creates a more interactive and engaging learning environment for teachers and learners thus changing the role of the teacher from knowledge transmitter to that of a facilitator, knowledge navigator and a co-learner. Keengwe, Onchwari and Wachira (2008) assert that the application of multi-media technologies (i.e., those that combine text, graphics, video, animation and audio) in teaching and learning ensures a very productive, interesting, motivating, interactive and quality delivery of classroom instruction while addressing diverse learners' needs.

2 Purpose and Method

Given the importance of IITL, one goal of research on IITL is to identify its factors, which may in turn be manipulated to positively influence IITL. In deriving the factors of IITL, several theories can be considered. Of these theories, this paper reviews six, with a view to isolating gaps for future research. The six theories are the Theory of Reasoned Action (TRA), the Technology Acceptance Model (TAM), the Technology-Organisation-Environment (TOE) framework, the Theory of Planned Behaviour (TPB), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technological Pedagogical Content Knowledge (TPACK) framework. The review is chronological. In order to achieve this objective, we sourced for the seminal article for a given theory, which we used to introduce the theory. Then we sought at least one recent literature (or indeed, theoretical) review and/ or meta-analysis on the theory to use it to give the trend of past researches on the theory and the gaps left for future studies.

3 Theories of IITL

3.1 Theory of Reasoned Action

Ajzen and Fishbein (1980) developed the Theory of Reasoned Action (TRA) shown in Figure 1. According to Figure 1, the TRA model has actual behaviour

(AB) as its main variable. Ajzen and Fishbein defined AB as an individual's observable response in a given situation with respect to a given target. As per Figure 1, AB is postulated to be determined by behavioural intention (BI), which Ajzen and Fishbein defined as the cognitive representation of an individual's readiness to perform intended behaviour. TRA theorises that BI in turn, is jointly determined by the individual's attitude toward the behaviour (ATB) in question and the pertinent subjective norm (SN). According to Ajzen and Fishbein, ATB is the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question, while SN is the perceived social pressure to perform or not to perform the behaviour.

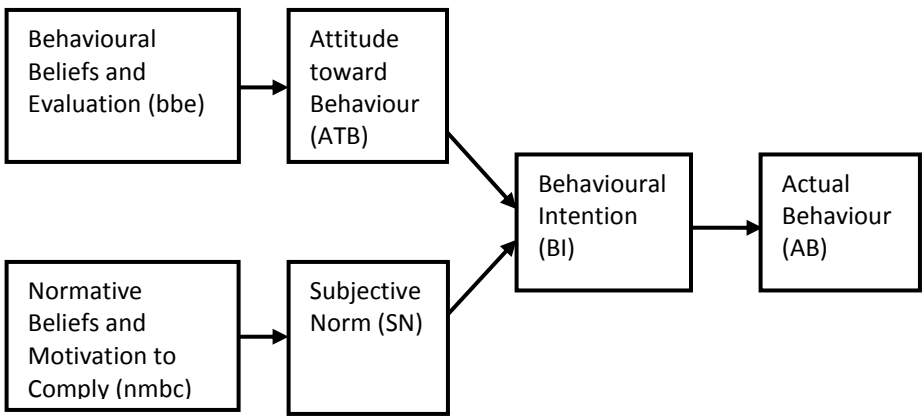

Figure 1: The Theory of Reasoned Action
Source: Ajzen and Fishbein (1980), page 17, Figure 1.2

According to Figure 1, ATB is influenced by behavioural beliefs and evaluation (bbe). Behavioural beliefs (bb) are the individual subjective probability that performing the target behaviour will result in consequences, and evaluation (e) is a rating of the desirability of the outcome (Ajzen & Fishbein, 1980). Ajzen and Fishbein asserted that individuals are rational decision makers who constantly calculate and evaluate the relevant behavioural beliefs (bb) in the process of determining their ATB. As per Figure 1, TRA theorises that SN is influenced by normative beliefs and motivation to comply (nbmc). Normative beliefs (nb) are the likelihood that important individuals or group approve or disapprove of performing a given behaviour, and motivation to comply (mc) is the extent to which the individual wants to comply with the wishes of the referent other (Ajzen, 1991).

Theoretical reviews on the TRA model such that of Otieno, Liyala, Odongo and Abeka (2016) are available. Otieno et al. carried out a theoretical review to compare the TRA model with other theories and/ or models. The other theories/

models included the Technology Acceptance Model (TAM), the Technology Organisation Environment (TOE), the Theory of Planned Behaviour (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT). However, although Otieno et al. claimed to have used the qualitative approach in their review they never specified the procedure in selecting the studies for review and how they went about the analysis.

Nevertheless in terms of findings, Otieno et al. revealed that most of the studies they reviewed on the TRA model had been on consumer adoption across disciplines and cases including dieting, using condoms, consuming engineered foods rather than in innovation technology. In addition, they also noted that while theories such as TAM, TOE and UTAUT had been employed over the years in understanding users' adoption behaviour in technology related studies, the TRA model had received less attention, a gap that needs to be addressed. Yet, according to them, social psychology based theories such as TRA, do have a better platform in studying adoption of new innovation technology.

Apart from the theoretical reviews (e.g. Otieno et al., 2016) on the TRA model, other researchers have conducted meta-analyses on the model. For example, Sheppard, Hartwick and Warshaw (1988) conducted a meta-analytic review on the effectiveness of the TRA model in research and to assess the degree to which research utilizing the TRA model had gone beyond the intended conditions of the model. Sheppard et al. used online searches to obtain empirical studies that had been published in the *Journal of Consumer Research*, the *Journal of Marketing*, the *Journal Advances in Consumer Research*, the *Journal of Personality and Social Psychology* and the *Journal of Applied Social Psychology*.

They hence reported that their review had suggested that,

> more than half of the research to [that] date that ha[d] utilised the [TRA] model ha[d] investigated activities for which the model was not originally intended.... However, to [their] surprise, the model [had] performed extremely well in the prediction of... [such] activities.... Thus,... the... [TRA] model ha[d] strong predictive utility.... (p. 338).

In conclusion, they lauded the TRA model and called upon researchers to continue using it in their researches for purposes of refining it. In their own words, they observed that,

> In 1975, Fishbein and Ajzen placed a compelling and coherent structure on the field of attitudes, which was in disarray before their work. That accomplishment should mark the starting point for important empirical and theoretical work in the field, not its end. In particular, appropriate modification of the original... model should be investigated further (p. 340).

3.2 Technology Acceptance Model

The Technological Acceptance Model (TAM) in Figure 2, developed by Davis (1989), has actual system use (ASU) as the main variable. Davis defined ASU as an individual's observable usage of a particular system (e.g. technology). Figure 2 suggests that ASU is a direct function of behavioural intention to use (BIU) a technology, which Davis defined as the degree to which a person has formulated conscious plans to perform or not to perform some specific future behaviour. BIU is in turn, a function of attitude toward using (ATU) and perceived usefulness (PU).

ATU is an individual's positive or negative feeling about performing the target behaviour (Davis, Bagozzi & Warshaw, 1989), while PU is the degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989). According to Figure 2, PU is influenced by perceived ease of use (PEU), which Davis defined as the degree to which a person believes that using a particular technology would be free from effort. Figure 2 further suggests that ATU is determined jointly by PU and PEU.

According to Figure 2, TAM theorises that in turn, each of PU and PEU is influenced by external variables (e.g. system characteristics, development process, and training). However, other explanatory variables notwithstanding, the proponents of TAM (e.g. Davis, 1989) posit that PU and PEU are the two fundamental determinants of ASU. They argue that if users find a technology useful (i.e. having PU) and easy to use (i.e. having PEU), then they develop a positive attitude toward using (ATU) this technology. All these will eventually lead to the behavioural intention to use (BIU) the technology and finally the actual use of the technology (ASU).

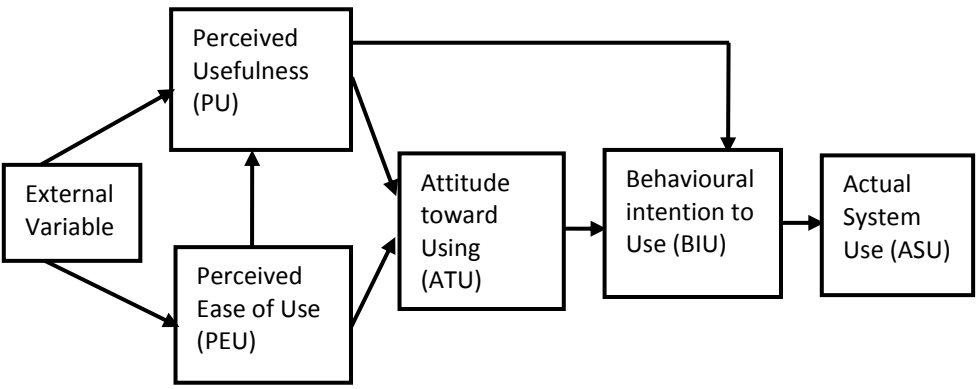

Figure 2: The Technology Acceptance Model (TAM)
Source: Davis et al. (1989), page 985, Figure 2.

Several researchers have carried out literature reviews on the TAM model. For example, Chuttur's (2009) review provided a historical overview of the TAM in the information system (IS) literature from 1985 to 2007, by focusing on its evolution, applications, extensions, limitations and criticisms. However, he never revealed how he selected the papers for the review, and how he went about the analysis. In terms of findings however, Chuttur reported that the TAM model had indeed been very popular for explaining and predicting system use. However, most of the studies he reviewed had the weakness of only concentrating on self-reported data as opposed to observed measures, which was a gap for future studies.

Also, according to Chuttur (2009) most of the studies he reviewed had focused only on voluntary environments with little consideration for mandatory settings thus leaving a gap to be filled by future researchers on TAM by extending to mandatory settings. He also found out that several studies on the TAM had made use of students as participants, yet according to him, the results obtained from such studies could not be generalised to the real world because students may have peculiar motivations in performing a given behaviour (e.g. use of ICT) such as the need to obtain good grades and rewards among others. Furthermore, Chuttur established that most of the studies he reviewed had been conducted in the US, and UK and very few in other parts of the world particularly in Africa, hence a contextual gap that needed attention by future researchers on the TAM.

Apart from those who reviewed literature on the TAM, researchers have conducted meta-analytic reviews on the model. For example, King and He (2006) conducted a meta-analytic review of 88 published articles to examine to effectiveness and robustness of the TAM in research. Using online search and the Social Science Citation Index (SSCI), they obtained empirical papers on the model. In terms of findings, King and He established that the TAM had been widely used in information system (IS) studies.

According to King and He (2006), both perceived usefulness (PU) and perceived ease of use (PEU) had been relevant measures that could be used in a variety of contexts. They also revealed that the correlation between PU and behavioural intention to use (BIU) different technologies had been stronger than that of PEU to BIU; and that both PU and PEU had jointly explained about 50% of the variance in BIU. However, they noted that while TAM correlations had been strong, they had had considerable variability suggesting that moderator variables if added could help to explain the effects.

3.3 Technology-Organisation-Environment Framework

Tornatzky and Fleischer (1990) developed the Technology-Organisation-Environment (TOE) framework shown in Figure 3. The TOE framework

(Figure 3) theorises that technological adoption decision making, the main variable, is influenced by three principal contexts namely; the technological, organizational and environmental.

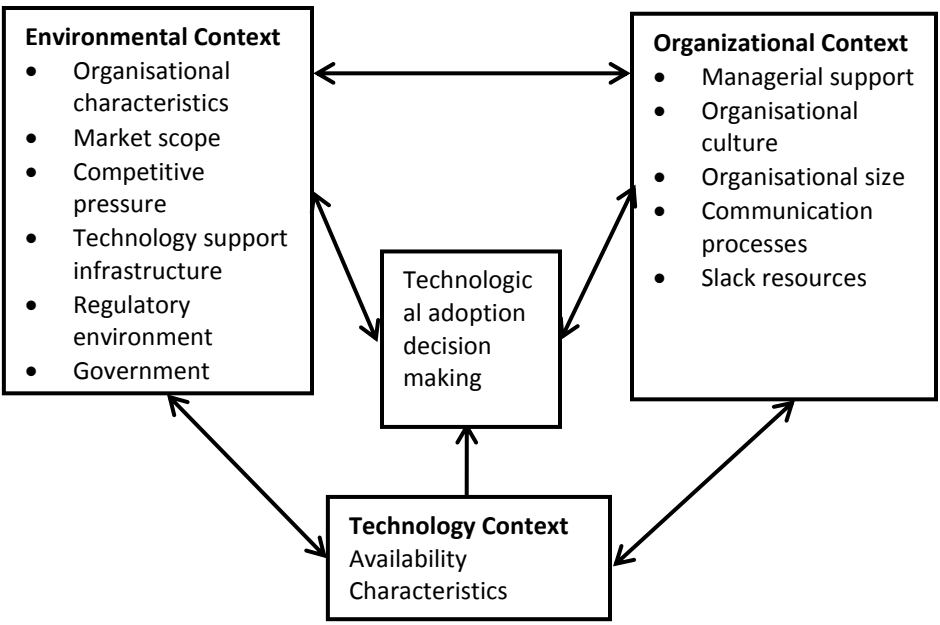

Figure 3: Technology-Organisation-Environment (TOE) framework
Source: Tornatzky & Fleischer (1990), page 32, Figure 3-1.

Tornatzky and Fleischer (1990) defined the technological context as the internal and external technologies that are relevant to the organisation and according to them, may include both equipment as well as processes. Tornatzky and Fleischer observed that adoption of an innovation depends on the pool of technologies inside and outside an organisation as well as the perceived characteristics (e.g. relative advantage, compatibility, complex, triability, and observability) of the innovation. The organizational context are the characteristics and resources of the organization such as managerial support, organisational culture and size, communication processes, and the amount of slack resources an organisation has (Tornatzky & Fleischer, 1990).

The environmental context as Figure 3 suggests, is the setting in which the organisation conducts its business. According to the TOE framework the environmental context includes the organisation itself, market scope, competitive pressure, technology support infrastructure and regulatory environment. Several researchers have reviewed literature on the TOE framework. For example, Baker (2012) reviewed studies that had used the TOE

framework, noting the type of innovation that was being adopted in each study. He also suggested directions for future research with the TOE framework. He summarised his review as follows:

> To this point the majority of theoretical development that has taken place related to the TOE framework has been limited to enumerating the different factors that are relevant in various adoption contexts. No new constructs have been added to the framework. Little theoretical synthesis has occurred. Scant critique has been offered. Thus, the TOE framework has evolved very little since its original development (p. 237).

As to why there has hardly been any development for the TOE framework, Baker (2012) suggested three reasons, of which we give two here. First, he contended, "the TOE framework has been described as a 'generic' theory" (p. 237), giving researchers "the freedom to vary the factors or measures for each new research context" (p. 237), making the TOE framework highly adaptable. "Thus, scholars have little need to adjust or refine the theory itself" (p. 237). Second, according to Baker, the TOE framework has seen relatively little evolution because it is aligned with other theories of innovation, particularly Rogers' Innovation Diffusion Theory (Rogers, 2003) - rather than offering a competing explanation to them. He ended by calling upon researchers, "to craft a refined version of the TOE framework that is at the same time parsimonious and broadly applicable" (p. 243).

3.4 Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) as shown in Figure 4, was developed by Ajzen (1991), and has actual behaviour (AB) as the main variable. Ajzen defined AB as an individual's observable response in a given situation with respect to a given target. According to Figure 4, TPB theorises that AB is predicted by both behavioural intention (BI) and perceived behavioural control (PBC). Ajzen defined BI as an indication of a person's readiness to perform a given behaviour and PBC as the perceived ease or difficulty of performing the behaviour.

As per Figure 4, BI is in turn, determined by the attitude toward the behaviour (ATB) in question, the pertinent subjective norm (SN) and PBC. Note that ATB and SN are already defined in section 3 of this paper. According to Figure 4, TPB theorises that ATB is influenced by behavioural beliefs and outcome evaluations (bboe). SN is influenced by normative beliefs and motivation to comply (nbmc). Note that bboe and nbmc are already defined in section 3 of this paper.

Further, according to Figure 4, TPB model posits that PBC is determined by control beliefs and perceived facilitation (cbpf). Ajzen (1991) defined control

beliefs (cb) as a perception of the availability of skills, resources and opportunities; and perceived facilitation (pf) as the individual's assessment of the importance of those resources to the achievement of outcomes. Ajzen (1991) observed that TPB (Figure 4) extended TRA (Figure 1) by incorporating PBC as a set of factors that affect BI and AB.

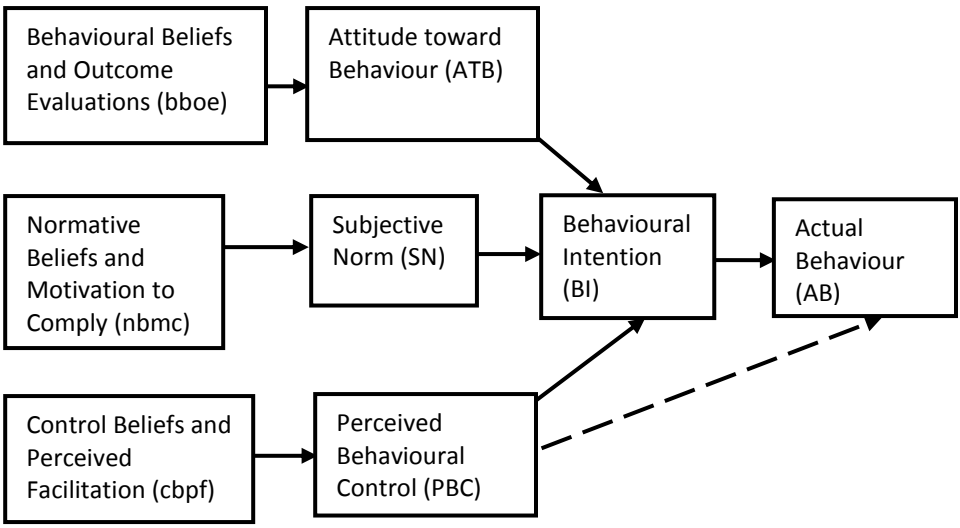

Figure 4: The Theory of Planned Behaviour (TPB)
Source: Ajzen (1991), page 182, Figure 1.

Researchers have conducted meta-analytic reviews on the TPB model. For instance, Notani's (1998) meta-analysis examined the role of perceived behavioural control (PBC) in predicting behavioural intention (BI) and actual behaviour (AB). Notani also assessed the robustness of the TPB model. Notani used a search of ABI Inform, Psychological Abstracts, Psychlit databases, and references in published articles, thus obtaining 36 articles. In terms of findings, Notani reported that the TPB model had "performed well, with perceived behavioural control [PBC] serving as an antecedent to both behavioural intention [BI] and [actual] behaviour [AB]" (p. 247). He also revealed that, PBC "is a stronger predictor of [actual] behaviour [AB] when it (a) is operationalised as a global (vs. belief-based) measure; (b) is conceptualised to reflect control over factors primarily internal (vs. external) to an individual, and (c) is used for nonstudent (vs. student) samples and familiar (vs. unfamiliar) behaviour" (p. 247).

3.5 Unified Theory of Acceptance and Use of Technology

Venkatesh, Moris, Davis and Davis (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) shown in Figure 5. The UTAUT (Figure 5) has use behaviour (UB) as the main variable, which Venkatesh et al. defined as the degree to which a person accepts and uses a new technology. According to Figure 5, UB is a function of behavioural intention (BI) and facilitating conditions (FC). BI is a measure of the strength of one's intention to perform a specific behaviour (Davis et al., 1989), while FC is the degree to which an individual believes that organisational and technical infrastructure required for the support of the technology exists (Venkatesh et al., 2003).

BI is in turn, as illustrated in Figure 5, determined by performance expectancy (PE), effort expectancy (EE) and social influence (SI). Venkatesh et al. defined PE as the degree to which an individual believes that using the technology will help him or her to attain gains in job performance; EE as the degree of ease associated with the use of the technology; and SI as the degree to which an individual perceives that important others believe that he or she should use the technology.

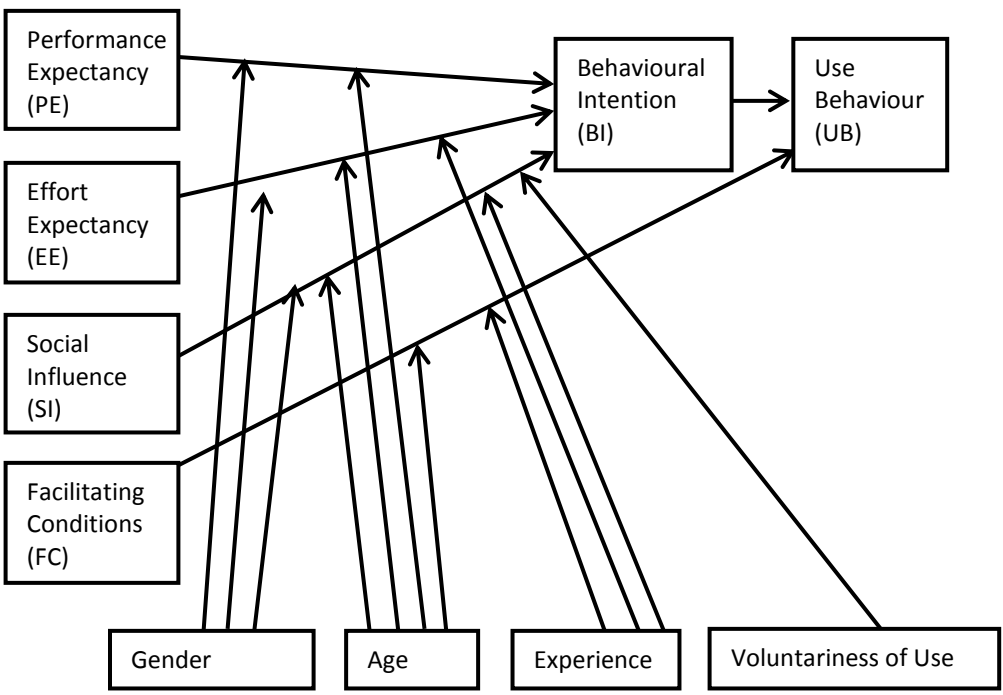

Figure 5: The Unified Theory of Acceptance and Use of Technology (UTAUT) Model
Source: Venkatesh et al. (2003), page 447, Figure 3.

According to Figure 5, the influence of PE on BI is moderated by gender and age while that of EE on BI is moderated by gender, age and experience of the individual. Experience is the expertise one has as a result of using a particular technology. The influence of SI on BI is moderated by gender, age, experience and voluntariness of use. Voluntariness of use is the degree to which an individual perceives the use of the technology as being based on free will (Venkatesh et al., 2003). As per Figure 5, the direct influence of FC on UB is moderated by age and experience of an individual user of the technology in question.

In developing the UTAUT, Venkatesh et al. based on eight technology acceptance theories or models, which included TRA, TAM and TPB which have already been reviewed in (sections 3 through 5 of) this paper. Several researchers have conducted meta-analyses on the UTAUT framework. For example, Dwivedi, Rana, Chen and Williams (2011) conducted a meta-analytic review of 43 empirical studies on the UTAUT framework that they got from the Web of Science database. Hence, Dwivedi et al. reported that PE had shown the strongest correlation with BI followed by SI, EE and FC throughout the studies they reviewed.

In addition, they revealed that only eight out of the 43 studies had studied the relationships between BI and use behaviour (UB) while the remaining 35 only examined how four UTAUT constructs (PE, EE, SI & FC) related to BI. Such findings suggest that most researches on UTAUT had not used the dependent variable (UB) as the model (Figure 5) requires. Instead they had used BI which is just a moderating variable in the UTAUT model. This is a glaring gap that warrants attention by future researchers. They identified another gap to the effect that most empirical studies they reviewed on the UTAUT model had been more of quantitative than qualitative and mixed approaches.

3.6 Technological Pedagogical Content Knowledge Framework

Mishra and Koehler (2006) developed the Technological Pedagogical Content Knowledge (TPACK) framework depicted in Figure 6.

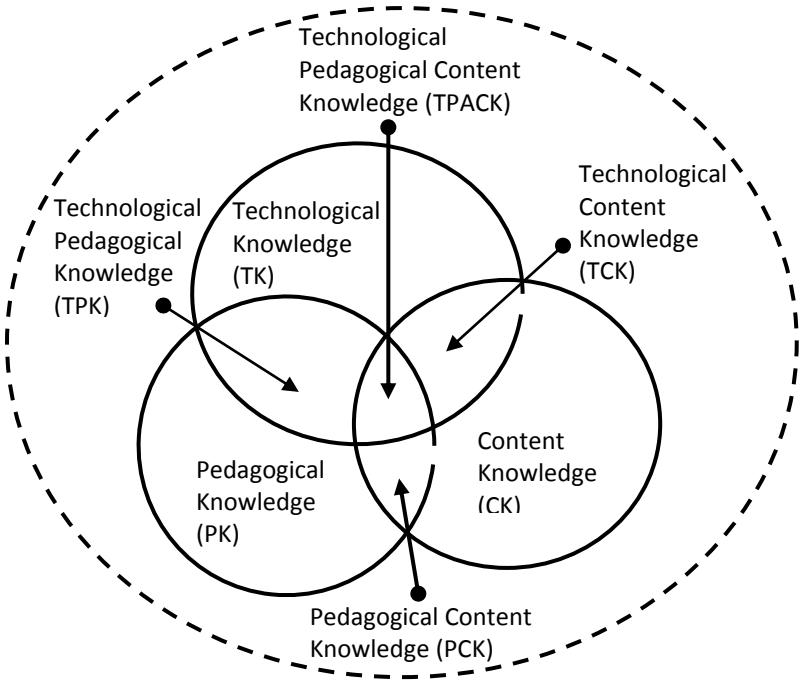

Figure 6: The TPACK framework
Source: Mishra & Koehler (2006), page 1025, Figure 4.

According to the TPACK framework (Figure 6), Mishra and Koehler posit that a teacher depends on three domains of knowledge for effective integration of ICT into teaching and learning (IITL). The domains are content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). Mishra and Kohler (2006) defined CK as knowledge about the actual subject matter that is to be learned or taught. Mishra and Koehler observed that a teacher must know and understand the subject that he/ she teaches, including knowledge of central facts, concepts, theories, and procedures if the teacher is to integrate technology in teaching.

Mishra and Koehler (2006) defined PK as the deep knowledge about the processes or methods of teaching and learning (e.g. values and aims, classroom management, lesson planning, and student evaluation). They argued that a teacher with deep PK is likely to integrate technology in his or her teaching considering how students can best learn in a given classroom context and nature of learners. Mishra and Kohler defined TK as knowledge about standard technologies, such as books, chalkboard, and more advanced technologies such as the Internet and digital video and how to operate those technologies. They asserted that a teacher with TK has good knowledge of operating system and

computer hardware, the ability to use standard sets of software tools (e.g. word processors, spreadsheets, browsers, e-mail) and how to install and remove peripheral devices, install and remove programmes, create and archive documents among others.

Mishra and Kohler (2006) as Figure 6 suggests, observed that the interaction of these three knowledge domains; CK, PK and TK gives rise to three paired knowledge domains namely pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK). Mishra and Kohler defined PCK as the knowledge of pedagogy that is applicable to the teaching of specific content such as knowing what teaching approaches fit content, and likewise, knowing how elements of the content can be arranged for better teaching. Mishra and Koehler defined TCK as the knowledge about the manner in which technology and content are reciprocally related. They further asserted that a teacher needs to know not just the subject matter he/ she teaches but also the manner in which the subject matter can be changed by the application of technology.

Mishra and Kohler (2006) defined TPK as knowledge of the existence, components and capabilities of various technologies as they are used in teaching and learning settings and conversely, knowing how teaching might change as the result of using particular technology. According to Figure 6, TPACK is the intersection of all the three bodies of knowledge (CK, PK & TK). Mishra and Kohler argued that the development of TPACK by teachers is central for effective teaching with technology because understanding TPACK is above and beyond understanding technology, content, or pedagogy in isolation, but rather how these forms of knowledge interact with each other.

Researchers have systematically reviewed literature on the TPACK framework. For example, Wu (2013) reviewed 24 empirical studies on the framework to help educators and researchers in understanding the "current" TPACK research progress and choosing appropriate topics for further investigation. Having sourced the papers published between 2002 and 2011 from the Social Science Citation Index (SSCI) database, Wu reported that TPACK research had received increased attention from researchers and educators during the decade before the study. In addition, he found out that only two out of 24 TPACK studies he reviewed had been published between 2002 and 2006 while 22 had been published between 2007 and 2011.

Wu finally raised gaps in the studies he had reviewed to the effect that pre-service teachers had dominated TPACK researches. For example, while 54.2 % of the studies had involved pre-service teachers, only 20.8% had involved in-service teachers and 8% university faculty, suggesting further research could focus on in-serve teachers' TPACK. He further indicated that the most frequently research methods used in the TPACK studies published between 2002 and 2011 had been quantitative (45.8%) followed by the qualitative

(41.7%) and the mixed method ones (12.5%) although such percentages might have resulted from the to small sample of 24 papers he had reviewed. However, Wu noted that between 2002 and 2006 only qualitative research methods had been used in the TPACK studies he had reviewed.

4 Conclusion

When used appropriately, ICTs help in expanding access to education through faster information distribution and availability anytime and anywhere (Aktaruzzaman et al., 2011). Given the importance of the integration of ICT in teaching and learning (IITL), one goal of research thereof is to identify its factors, which may in turn be manipulated to positively influence IITL. While in deriving the factors of IITL, several theories can be considered, this paper has reviewed six of them, and isolated gaps for future research. It is our hope that this review will hence trigger more researchers in the area of IITL in particular, and the use of innovations in general.

References

Ajzen, I. (1991). The Theory of Planned Behaviour. *Organizational Behaviour and Human Decision Processes, 50,* 179-211.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour.* Englewood Cliffs, NJ: Prentice-Hall.

Aktaruzzaman, M., Shamim, M. R. H., & Clement, C. K. (2011). Trends and issues to integrate ICT in teaching and learning for the future world of education. *International Journal of Engineering and Technology, 11*(3), 114-199. Retrieved from: http://ijens.org/Vol%2011%20I%2003/118603-0202%20IJET-IJENS.pdf.

Baker, J. (2012). The Technology-Organization-Environment framework. In Y. K. Dwivedi, M. R. Wade, & S. L. Schneberger (Eds.), *Information systems theory: Explaining and predicting our digital society*, *Vol 1* (pp. 231-245). doi: 10.1007/978-1-4419-6108-2_12

Chuttur, M. Y. (2009). Overview of the Technology Acceptance Model: Origins, development and future directions. *Working Papers on Information System, 9*(3), 9-37. Retrieved from: http://sprouts.aisnet.org/.

Coleman, L. O., Gibson, P., Cotten, S. R., Howell-Moroney, M., & Stringer, K. (2016). Integrating computing across the curriculum: The impact of internal barriers and training intensity on computer integration in the elementary school classroom. *Journal of Educational Computing Research, 54*(2), 275-294. doi: 10.1177/0735633115616645.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and use acceptance of information technology. *MIS Quarterly, 13*(3), 319-339.

Davis, F., Bagozzi, R., & Warshaw, P. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982-1003.

Dwivedi, Y. K., Rana, N. P., Chen, H., Williams, M. D. (2011). A meta-analysis of the Unified Theory of Acceptance and Use of Technology (UTAUT). In M. Nuttgens, A. Gadatsch, K. Kautz, I. Schirmer, & N. Blim, (Eds.), *Governance and sustainability in information systems, IFIP AICT366* (pp. 155-170). doi: 10.1007/978-3-642-24148-2_10

Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science, 1*(2), 175-191.

Hughes, J. E. (2013). Descriptive indicators of future teachers' technology integration in the PK-12 classroom: Trends from a laptop-infused teacher education program. *Journal of Educational Computing Research, 48*(4), 491-516. Retrieved from: http://dx.doi.org/10.2190/EC.48.4.e.

Keengwe, S., Onchwari, G., & Wachira, P. (2008). The use of computer tools to support meaningful learning. *AACE Journal, 16*(1), 77-92.

King, W. R., & He, J. (2006). A meta-analysis of the Technology Acceptance Model. *Information and Management, 43,* 740-755. doi: 10.1016/j.im.2006.05.003

Mishra, P., & Koehler, M. (2006). Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teacher College Record, 108*(6), 1017-1054.

Notani, A. S. C. (1998). Moderators of perceived behaviour control's predictiveness in the Theory of Planned Behaviour: A meta-analysis. *Journal of Consumer Psychology, 7*(3), 247-271. Retrieved from: http://www.jstor/stable/14480592.

Otieno C, O., Liyala, S., Odongo, C. B., & Abeka, S. (2016). Theory of Reasoned Action as an underpinning to technological innovation adoption studies. *World Journal of Computer Application and Technology, 4*(1), 1-7. doi: 10.13189/wjcat.2016.040101

Rogers, E. M. (2003). *Diffusion of innovations*. New York: Free Press.

Sheppard, B., Hartwick, J., & Warshaw, P. R. (1988). The Theory of Reasoned Action: A meta-analysis of past research with recommendations for modifications for future research. *The Journal of Consumer Research, 15*(3), 325-343. Retrieved from: http://links.jstor.org/sici?=0935301%28198812%3A3%3c325%ATTORAA%3E2.0.CO%3B2.9.

Tornatzky, L. G., & Fleischer, M. (1990). *The process of technological innovation*. Lexington: Lexington Books.

Venkatesh, V., Morris, M. G., Davis G. B., & Davis F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, *27* (3), 425-478.

Wu, Y. (2013). Research trends in Technological Pedagogical Content Knowledge (TPACK) research: A review of empirical studies. *British Journal of Educational Technology, 44*(3), 73-76. doi: 10.1111/j.1467-8535.2012.01349.x.