# TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK) AS A THEORY ON FACTORS OF THE USE OF ICT IN PEDAGOGY: A REVIEW OF LITERATURE

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**Abstract**
The use of ICT in pedagogy has a positive impact on the teaching and learning process. While ICT in pedagogy is an undertaking involving stakeholders like teachers, administrators and students, teachers are considered to play a core role in the use of ICT in pedagogy. What factors will then make the teachers use ICT in pedagogy? In deriving the factors affecting the adoption of an innovation, such as ICT in pedagogy, several frameworks are available. Of these frameworks, we review some of the traditional innovation adoption frameworks namely, the Innovation Diffusion Theory (IDT), the Technology Acceptance Model (TAM), the Technology-Organization-Environment (TOE) framework, and the Unified Theory of Acceptance and Use of Technology (UTAUT). We find that all the above models have been widely employed in guiding innovation adoption studies. We notably argue that the Technological Pedagogical Content Knowledge (TPACK) framework can be included on the list of innovation adoption models. Thirdly, we review past studies on TPACK and isolate pertinent gaps. Hence we develop a framework basing on TPACK, and derive hypotheses to guide further studies on the factors related to the use of ICT in pedagogy by teachers and call for a paradigm shift to have large scale quantitative studies testing whether the TPACK constructs relate to the levels of use of ICT in pedagogy.
**Keywords:** ICT; Knowledge; Pedagogy; TPACK

## 1 Introduction

Majumdar (2006) observed that ICT like computers, web 2.0 technologies, internet, email and video conferencing provide an array of powerful tools that induce the transformation of the isolated teacher-centered and text-bound classrooms into rich student-focused interactive knowledge environments. According to him, the use of ICT in pedagogy helps the learners not only to access information in a variety of communication styles but it also helps the learners to benefit from collaborative learning which as a result augments creative thinking and problem solving skills. We can therefore safely say that the use of ICT in pedagogy has a positive impact on the teaching and learning process. While ICT in pedagogy is an undertaking involving stakeholders like teachers, administrators and students, teachers are considered to play a core role in the use of ICT in pedagogy (Voogt & Knezek, 2008).

What factors will then make the teachers use ICT in pedagogy? In deriving the factors affecting the adoption of an innovation, such as ICT in pedagogy, several frameworks are available. Of these frameworks, we intended (i) to review some of the traditional innovation adoption frameworks namely, the Innovation Diffusion Theory (IDT), the Technology Acceptance Model (TAM), the

Technology-Organization-Environment (TOE) framework, and the Unified Theory of Acceptance and Use of Technology (UTAUT); (ii) to argue that Technological, Pedagogical, and Content Knowledge (TPACK) can be included on the list of innovation adoption models; (iii) to review past studies on TPACK; and hence (iv) to develop hypotheses basing on TPACK to guide further studies on the factors related to the use of ICT in pedagogy by teachers.

## 2 Traditional Theories on Innovation Adoption

Our first objective is to review some of the traditional models which guide studies on innovation adoption. These include the IDT (subsection 2.1), the TAM (subsection 2.2), the TOE framework (subsection 2.3), and the UTAUT (subsection 2.4).

***2.1 Innovation Diffusion Theory:*** Rogers' Innovation Diffusion Theory (IDT) is one of the several frameworks for guiding studies on the factors related to the adoption of innovations. Although referred to as Rogers' IDT in this research, according to Bakkabulindi (2014), it was originally termed the "Paradigm of Innovation-Decision Process" as was proposed by Rogers after his doctoral studies on the diffusion of agricultural innovations at Iowa State University, US, in 1958. Bakkabulindi further contends that the IDT also takes on several terms such as the Classical Innovation Theory, the Diffusion of Innovations, and the Diffusion Theory among others. According to Rogers (2003), the IDT relates innovation adoption to three categories of correlates. The categories of correlates are, the characteristics of the individual potential adopter, how the adopter perceives the innovation, and the characteristics of the social system. The social system refers to the organization where the potential adopter is.

Concerning the individual characteristics of the potential adopter as correlates of innovation adoption, Rogers (2003) specifies that an individual's tendency to adopt any innovation such as ICT in pedagogy is contingent on the individual characteristics of that person. According to Bakkabulindi (2014), such individual adopter characteristics incorporate the level to which that person intermingles with the change agents of significance to the innovation in question; the degree of training of significance to the innovation the person has received; how cosmopolitan the person is (cosmopolitan refers to urban influence or non-conservativeness); the age; the sex; and the income level of the person. With regard to the perceived characteristics of the innovation as correlates of innovation adoption, Rogers' IDT specifies that an individual's susceptibility to use any innovation is contingent on the way that individual perceives the innovation in terms of its relative advantage (PRA), compatibility (PC), complexity (PCx), trialability (PT), and observability (PO) among others

Rogers defined PRA as "the degree to which an innovation is perceived as being better than the idea it supersedes" (p. 229); PC as "the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters" (p. 15); and PCx as "the degree to which an innovation is perceived as relatively difficult to understand and use" (p. 15). Rogers (2003) further defined PT as "the degree to which an innovation may be experimented with on a limited basis" (p. 16), while PO is "the degree to which the results of an innovation are visible to others" (p. 16). On the nature of the social system as a factor of innovation adoption, Rogers insists that an individual's ability to adopt any innovation is determined by the organization where that individual is. That is to say, whether the social system is ready for change; has a good culture that facilitates change; has a size that is fit for change; and has a leader who facilitates change.

Several studies (e.g. Bakkabulindi, 2012; Bakkabulindi, Barigayomwe, Omuron, Ongia & Bashasha, 2016; Chen, 2014; Chigona & Licker, 2008; Mbatha, Ocholla, & Roux, 2011; Richardson, 2009; Zhang, 2015) that have used the IDT as a research framework in explaining the factors affecting the adoption of different innovations in various disciplines such as political science, history, education among others can be found. Others (e.g. Bakkabulindi, 2014; Oliveira & Martins, 2011; Sahin, 2006) have reviewed the literature on empirical studies that used the IDT. In particular, for example, Bakkabulindi (2014) was a literature review on the IDT that argued that other recent innovation adoption frameworks, such as the TAM (subsection 2.2); the TOE framework (subsection 2.3); and the UTAUT (subsection 2.4) were derived from the IDT. This implied that their wide applications are also applications of the IDT. In other words, as Bakkabulindi concluded, the IDT is very popular in theoretically supporting studies on innovation adoption.

***2.2 Technology Acceptance Model:*** Another traditional model related to innovation adoption is the Technology Acceptance Model (TAM), which was suggested by Davis (1989) after his doctoral studies at Massachusetts Institute of Technology (MIT). TAM suggests that perceived usefulness (PU) and perceived ease of use (PEOU) affect the behavioral intention (BI) to use an innovation, which in succession affects the actual use of that innovation. Davis defined PU as the prospective user's subjective possibility that using the innovation will boost job accomplishment. He also defined PEOU of an innovation as the extent to which a prospective user expects the innovation to be free of struggle. TAM is a popular framework because of its parsimony, thus many studies (e.g. Ajimon & Kumar, 2013; Alharbi & Drew, 2014; Fathema, Shannon, & Ross, 2015; Kim, 2014; Nair & Das, 2011, 2012; Park, 2009; Teo & Milutinovic, 2015; Wong, Osman, Goh & Rahmat, 2013) have used it as their theoretical basis. Other researchers (e.g. Awa, Ukoha & Emecheta, 2012; Nair & Das, 2011; Surendran, 2012) have reviewed literature on studies that involved TAM. The general consensus of such reviews is that the TAM has been greatly used to guide studies on the factors related to the adoption of innovations.

***2.3 Technology-Organization-Environment Framework:*** The Technology-Organization-Environment (TOE) framework developed by Tornatzky and Fleischer (1990) relates the adoption of an innovation to three categories of factors namely the characteristics of the technology being adopted, the characteristics of the organization where the potential adopter is, and the characteristics of the environment, where the potential adopter's organization is situated. According to Tornatzky and Fleischer, the technological context is the pool of technologies inside and outside an organization and the adoption of a technology depends on perceived relative advantage, compatibility, complexity, trialability, and observability of the technology. The organizational context refers to the characteristics of the organization such as a top management encouragement, organizational beliefs, the quality of human resource, and size related issues such as internal negligent resources and adaptation.

Tornatzky and Fleischer (1990) further defined the environmental context as the ground in which an organization manages its business, its clients, contenders, and dealings with the government. Several studies (e.g. Aboelmaged, 2014; Angeles, 2013, 2014; Bradford, Earp, & Grabski, 2014; Cao, Jones, & Sheng, 2014; Lippert & Govindarajulu, 2006; Ramdani, Chevers, & Williams, 2013; Scott, 2007; Yeh, Lee, & Pai, 2014) have taken advantage of this framework as their theoretical basis. Other scholars (e.g. Arpaci, Yardimci, Ozka & Turetken, 2012; Oliveira & Martins, 2011)

have reviewed literature concerning studies that employed the TOE. Hence one can discern that while the TOE framework is not as popular as say the TAM model, it has also been widely used.

***2.4 Unified Theory of Acceptance and Use of Technology (UTAUT):*** Venkatesh, Morris, Davis and Davis (2003) proposed and tested a unified innovation acceptance and use research model, which they called the Unified Theory of Acceptance and Use of Technology (UTAUT). The UTAUT was referred to as unified because it incorporates components across eight user acceptance models such as the IDT (subsection 2.1) and the TAM (subsection 2.2). UTAUT argues that a user's intentions to utilize any innovation and his/ her successive usage behaviors are affected by four main variables namely: performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). Venkatesh et al. defined PE as the extent to which using an innovation will offer benefits to consumers in carrying out certain activities; EE as the level of ease concomitant with consumers' use of an innovation; SI as the degree to which consumers recognize how important others (like family and friends) believe they should use a particular innovation; and FC as consumers' perceptions of the resources and help available to accomplish a behavior. The relationship between these determinants and dependent variables are regulated by age, gender, experience and voluntariness of the use of the innovation. Voluntariness of use refers to a selection being made of a person's free will, as opposed to being made as the result of coercion.

Various studies (e.g. Attuquayefio & Addo, 2014; Bakkabulindi, Mugagga, Shopi & Kabasiita, 2015; Hsu, 2012; Kabacki-Yurdakul, Ursavas, & Becit-Isciturk, 2014; Khechine, Lakhal, Pascot, & Bytha, 2014; Kim, 2014; Liu & Huang, 2015; Magsamen-Conrad, 2015; Oye, Noorminshah & Rahim, 2012; Venkatesh, Thong & Xu, 2012) have used UTAUT as their theoretical basis. Other researchers (e.g. Taiwo & Downe, 2013; Williams, Rana, Dwivedi & Lal, 2011) reviewed literature concerning the application of the UTAUT. In summary, while some reviewers (e.g. William et al., 2011) expressed reservations about the use of UTAUT, claiming that a large number of studies just cited UTAUT without actually utilizing it in their empirical research, other reviewers (e.g. Taiwo & Downe, 2013) have observed that many studies have increasingly used the UTAUT framework. Thus, the UTAUT framework has been reasonably used in guiding innovation adoption research.

## 3 Technological Pedagogical Content Knowledge (TPACK) Framework

Our second objective is to argue that TPACK can be added on the list of innovation adoption models. As mentioned in section 2 of this paper, many past studies in regard to the use of innovations such as ICT in pedagogy have focused on frameworks or models, such as the IDT (subsection 2.1), the TAM (subsection 2.2), the TOE framework (subsection 2.3) and the UTAUT (subsection 2.4). While all those frameworks suggest factors that may be important for innovation adoption, none of them presents knowledge as an important factor. To cater for this inadequacy, Mishra and Koehler (2006) offered a model to describe the nature of knowledge needed by teachers to effectively adopt the use of ICT in pedagogy.

Mishra and Koehler (2006) argued that, in order for teachers to use ICT in pedagogy, they need at least three domains of knowledge. The three domains are content knowledge (CK), pedagogical knowledge (PK) and technological knowledge (TK). Mishra and Koehler defined CK as the "knowledge about the actual subject matter that is to be taught" (p. 1026) and PK as the "knowledge about the processes and practices or methods of teaching and learning and how it

encompasses…overall educational purposes, values and aims' (p. 1026). They defined TK as the teachers' "knowledge about standard technologies, such as books, chalk and blackboard, and more advanced technologies, such as the Internet and digital video" (p. 1027). The interaction between the three primary knowledge domains, CK, PK and TK gives rise to three secondary knowledge domains namely pedagogical content knowledge (PCK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK). These combinations of knowledge, according to the TPACK framework, enhance the use of ICT in pedagogy by teachers.

Mishra and Koehler (2006) defined PCK as the "knowledge of pedagogy that is applicable to the teaching of specific content" (p. 1027). They defined TCK as the "knowledge about the manner in which technology and content are reciprocally related" (p.1028); and TPK as the "knowledge of 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 technologies" (p. 1028). When PCK, TCK and TPK knowledge domains interact, they form a triad, technological pedagogical content knowledge (TPACK), which according to Mishra and Koehler (2006), is the ideal combination of knowledge needed by a teacher to use ICT in pedagogy. The seminal article (Mishra & Koehler, 2006) defined TPACK as "an emergent form of knowledge that goes beyond all the three components (content, pedagogy, and technology)" (p. 1028). In summary, TPACK suggests seven knowledge domains namely; CK, PK, TK, PCK, TPK, TCK, TPACK as major determinants of the use of ICT in pedagogy by teachers as illustrated in Figure 1.

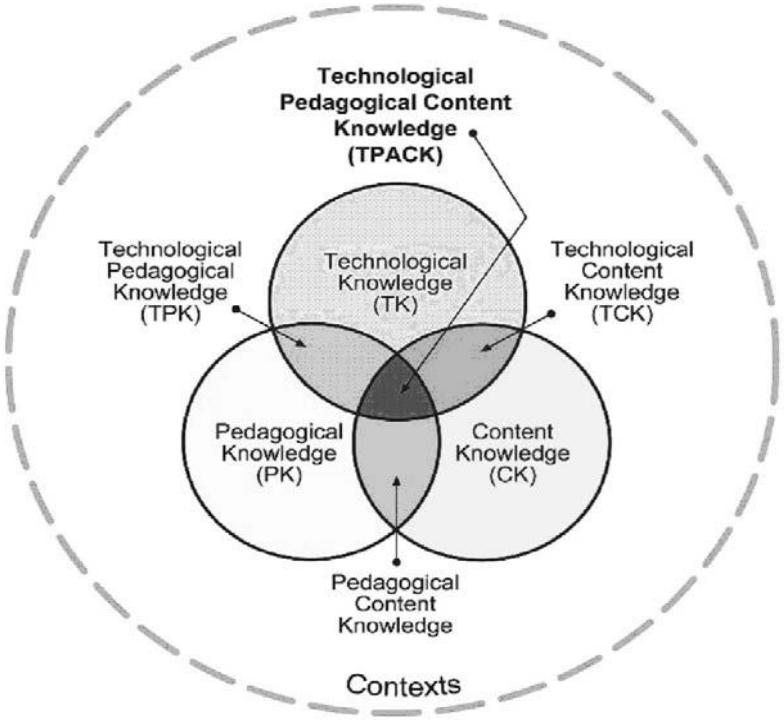


Figure 1: The TPACK framework
Source: Adapted from Mishra & Koehler (2006).

## 4 Past Studies on TPACK

Since the inception of the TPACK framework in 2006, several researchers have invested time and effort to employ it to guide their studies. Particularly, while some researches have made seminal contributions to TPACK, others have examined teachers and/ or students on how much TPACK they possessed. Yet others have had interest in the development of TPACK among teachers and/ or students. Some contributors have developed and tested survey instruments to measure TPACK, while others have reviewed literature on the progress of TPACK as a framework.

***4.1 Seminal Papers on TPACK:*** Papers (e.g. Angeli & Valanides, 2009; Koehler & Mishra, 2009; Koehler, Mishra, & Cain, 2013; Mishra & Koehler, 2006; Niess et al., 2009; Shulman, 1986, 1987) that have made original contributions to the development of the TPACK framework are available. In this section, we hint on the two (e.g. Mishra & Koehler, 2006; Shulman, 1986) that have perhaps been the most influential. As pointed out in section 3, the TPACK framework (Mishra & Kohler, 2006) suggests that a teacher's use of ICT in pedagogy, is contingent upon the teacher's knowledge, which knowledge has domains, namely content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK). While the main proponents of TPACK were Mishra and Koehler (2006), their independent variable (IV) was borrowed from Shulman (1986), a seminal article that articulated the importance of knowledge (K) to a teacher. Shulman stressed the importance of CK and PK to the teacher.

He gave seminal definitions to the two variables. In particular, he defined CK as "the amount and organization of knowledge per se in the mind of the teacher" (p. 9). Shulman also gave seminal definitions to PK as the knowledge of "how to teach" (Shulman, 1986, p. 6), and more solidly later as, "how teachers manage classrooms, organize activities, allocate time and turns, structure assignments, ascribe praise and blame, formulate the levels of their questions, plan lessons, and judge general student understanding" (p. 8). Shulman noted that CK and PK were inseparable, stressing that, "mere content knowledge [CK] is likely to be as useless pedagogically as content-free skill [i.e. PK]" (p. 8). Hence he proposed another major domain in TPACK, namely "pedagogical content knowledge" (PCK) for which he gave a seminal definition as, "pedagogical knowledge [PK], which goes beyond knowledge of subject matter per se [i.e. CK] to the dimension of subject matter knowledge for teaching [i.e. PK]" (p. 9).

Another major contribution of Shulman (1986) to TPACK was to call for the framework. In particular, Shulman noted that

> Although we often present propositions [e.g. on what knowledge a teacher needs in order to use ICT in pedagogy] one at a time, we recognize that they are better understood if they are organized in some coherent form, lodged in a conceptual or theoretical framework…. (pp. 10 – 11).

He later on added that, "the presentation of knowledge in the form of propositions has… a significant liability… [because] they become very hard to remember, especially if they aggregate into long lists. This is where theoretical frameworks as intellectual scaffoldings become indispensable" (p. 11). With such insights, Mishra and Koehler (2006) came up with the theoretical

framework, TPACK (Figure 1), to build on Shulman's PCK by including the knowledge of technology (TK) that teachers require in the teaching and learning process. The details of TPACK are already given elsewhere (section 3) in the paper.

***4.2 Papers on Examining How Much TPACK Teachers and/ or Students Possess:*** Efforts to examine the extent to which teachers and/or students possess TPACK have been made by several researchers (e.g. Doering, Veletsianos, Scharber, & Miller, 2009; Koh, Chai & Tsai, 2010; Nelson, Christopher, & Mins, 2009). For example, Doering et al. (2009) pursued to comprehend how social studies teachers' metacognitive responsiveness of their TPACK changed after they had participated in a program. The program comprised professional development for the use of, an online learning atmosphere in the classrooms. Doering et al. collected data from eight teachers from a mid-western city and its suburbs in the United States. Using the constant comparative method, they showed that the most positive change among the participants occurred in the technology knowledge (TK) category. They found that generally, five out of the eight teachers had indicated that their knowledge increased in at least one of the three knowledge components namely CK, PK and TK. However, the pedagogy knowledge (PK) component displayed mixed results, that is, three teachers had perceived an increase in their PK while three had perceived a decrease. Meanwhile, two teachers felt that their PK remained unchanged.

***4.3 Papers on the Development of TPACK by Teachers and/ or Students:*** There are several papers (e.g. Guzey, & Roehrig, 2009; Hannaway, 2016; Harris, & Hofer, 2009; Hosseini, 2015; Koh & Divaharan, 2011; Niess, 2005) on the development of TPACK by teachers and/ or students that can be cited. For example, Guzey and Roehrig (2009) examined the advancement of TPACK among four in-service secondary science teachers in the US as they took part in a professional development program named the Technology Enhanced Communities (TEC). Guzey and Roehrig introduced the science teachers in the program to probeware, mind-mapping tools, and the Internet. They employed a descriptive multi-case study design to footpath the advancement of the teachers over the yearlong program. They collected data through interviews, surveys and classroom observation. Using constant comparative analysis, they found that the program had had "positive impacts to varying degrees on teachers' development of TPACK" (p. 25). In particular, they found that, "contextual factors and teachers' pedagogical reasoning affected teachers' ability to enact in their classrooms what they learned in the program" (p. 25).

***4.4 Papers on the Development and Testing of Instruments to Measure TPACK:*** Several researchers (e.g. Landry, 2010; Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2009; Shinas, Yilmaz-Ozden, Mouza, Karchmer-Klein, & Glutting, 2013) have developed and tested instruments for measuring TPACK. For example, Landry (2010) intended to develop and validate a survey for measuring mathematics teachers' TPACK (M-TPACK). Landry used an existing survey (Schmidt et al., 2009) to create his instrument. Schmidt et al.'s instrument had 54 items with respect to mathematics, science, social studies and literacy. Landry eliminated all the other items except those of mathematics and as such came up with a new instrument that he termed M-TPACK. He used the M-TPACK survey to collect data from 149 middle school mathematics teachers. He selected these mathematics teachers from 14 public schools in Tennessee in the US. Using reliability analysis, he found that the M-TPACK was a reliable instrument. However, although he mentioned conducting

Exploratory Factor Analysis (EFA) to validate the M-TPACK survey, there was no evidence that he actually validated the survey.

***4.5 Literature Reviews on TPACK:*** Researchers (e.g. Jordan & Dinh, 2012; Lubke, 2013, Niess, 2011; Voogt, Fisser, Pareja-Roblin, Tondeur, & van Braak, 2013; Yilmaz, 2015) have reviewed literature on TPACK. For example, Jordan and Dinh (2012) provided a meta-analysis of papers for purposes of identifying the trends in the TPACK research industry. Using 98 papers sourced from the TPACK.org website which comprised of conference papers and journal articles published between 2006 and 2011, they showed that slightly more papers had been published in conference proceedings than journals. They noted that interest in the framework had generally increased over the review period, of which a peak may have occurred in 2009 and 2010. Furthermore, they observed that the papers had been more research-based rather than discussion papers or reports.

Jordan and Dinh (2012) found that pre-service teachers had figured more in the research on TPACK, followed by in-service teachers, and trailed by higher education students or faculty. They also revealed that mathematics teachers had tended to appear more in the research on TPACK than teachers of other disciplines. Most studies, they reported, had been produced by American researchers. Further, they reported that only a small portion of the studies that they reviewed had been quantitative in nature, hence calling for more quantitative studies. Jordan and Dinh also revealed that survey, interview, observation, and the collection of artifacts had been the regularly used ways of collecting data and that the instrument developed by Schmidt et al. (2009) had been used by numerous studies.

## 5 Hypotheses from TPACK: A Call for a Paradigm Shift

Following the literature review (section 4), it becomes apparent that research attention has been given to TPACK in the scholarly world. However, several gaps arise from such studies. For example, the studies on TPACK have dwelt more prominently on pre-service teachers, than in-service teachers (Lubke, 2013), and less so those in Higher Education (Jordan & Dinh, 2012). The cited studies also suggest a bias against the developing world (Jordan & Dinh, 2012). Studies on the TPACK framework have also been predominantly qualitative as opposed to quantitative. According to Jordan and Dinh (2012), survey, interview, observation, and the collection of artefacts were [the] commonly used ways of collecting data" (p. 6).

Hence a call is being made for a paradigm shift to have large scale quantitative studies testing whether the constructs of TPACK (CK, PK, TK, PCK, TCK, TPK, and TPACK) really relate to the levels of use of ICT in pedagogy (UIP). Unlike in all the previous studies, we are proposing that the constructs of TPACK should be measured separately from the construct of UIP, using standard quantitative measures such as Schmidt et al. (2009) for the constructs of TPACK and Puetendura (2010) for the construct of UIP. The proposed studies should now come from other areas than the US. To lead by example, the lead author of this research is carrying out her doctoral study examining the relevance of the TPACK framework in explaining the use of ICT in pedagogy by teachers of mathematical disciplines in Makerere University. Its synopsis (Batiibwe & Bakkabulindi, in press) is already accepted by a journal. In that study, on the basis of the TPACK framework (Figure 1), Figure 2 provides a framework relating the seven knowledge domains of

TPACK to UIP. The dependent variable which is UIP has been conceptualized as substitution, augmentation, modification and redefinition ICTs (Puetendura, 2010).

On the other hand, knowledge domains are conceptualized as content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK) and technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). Hence the following hypotheses are to be tested in the study (Batiibwe & Bakkabulindi, in press) using quantitative methods, such as correlation and regression:

H1: CK positively relates to UIP
H2: PK positively relates to UIP
H3: TK positively relates to UIP
H4: PCK positively relates to UIP
H5: TCK positively relates to UIP
H6: TPK positively relates to UIP
H7: TPACK positively relates to UIP

Independent Variables* Dependent Variable**

(TPACK Knowledge Domains) (Use of ICT in Pedagogy)

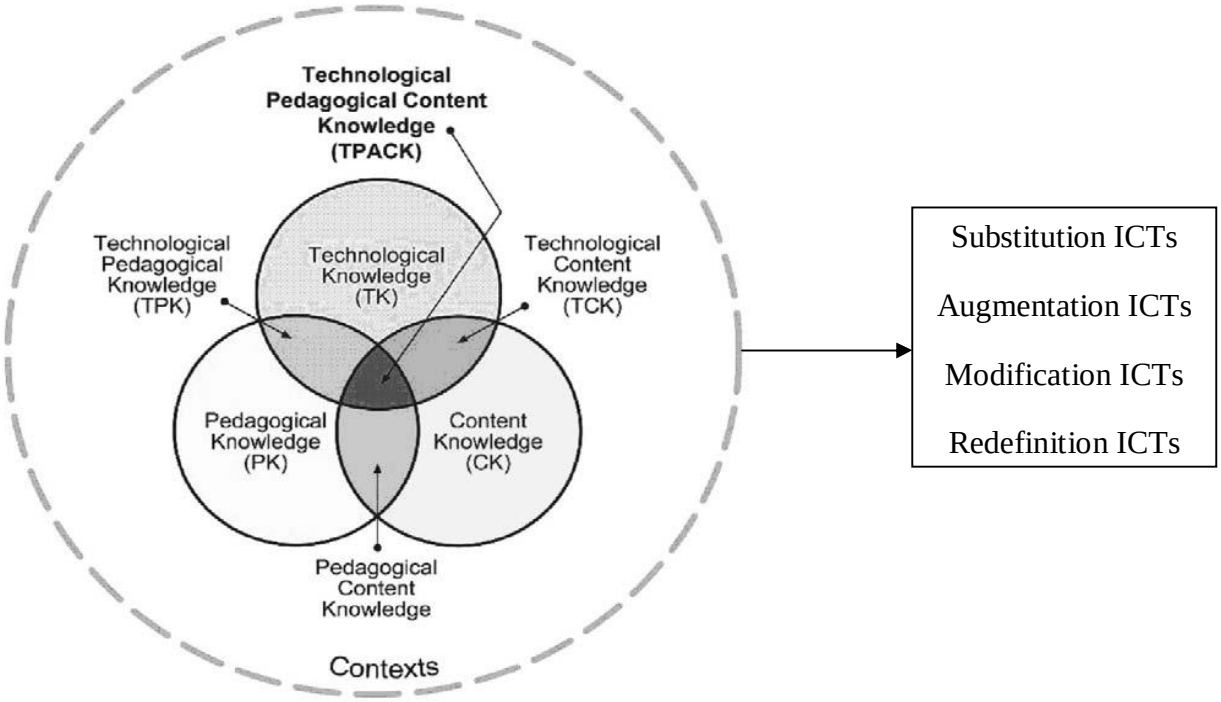


**Figure 2:** Conceptual framework relating the seven knowledge domains of TPACK to UIP

Source: Concepts adapted from *Mishra and Koehler (2006) and **Puetendura, (2010)

## 6 Conclusion

The use of ICT in pedagogy (UIP) has a positive impact on the teaching and learning process, hence the need to isolate factors related to UIP. Our review of the traditional innovation adoption frameworks namely, the IDT (subsection 2.1), the TAM (subsection 2.2), the TOE framework (subsection 2.3), and the UTAUT (subsection 2.4) has shown that all of these models have been widely used to guide studies on innovation adoption. We have argued that TPACK can be included on the list of innovation adoption models, specifically if the innovation in question is ICT in pedagogy. If we think of teachers as key in the use of ICT in pedagogy, then knowledge as described by the TPACK framework should be considered important. We have also reviewed past studies on TPACK, and raised gaps in them for future studies to close. Hence we have developed a conceptual framework, from which hypotheses to guide further positivist studies on the use of ICT in pedagogy can base.

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