

# PREPAREDNESS FOR CHANGE: TECHNOLOGICAL PEDAGOGICAL KNOWLEDGE FOR INTEGRATION OF INNOVATIVE TEACHING AND LEARNING TECHNOLOGIES IN TANZANIAN HIGHER EDUCATION

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## Abstract

*Despite the appreciated benefits and significant investment in technological integration, the integration of innovative teaching and learning technologies into higher education remains a major challenge. As such, this study sheds light on instructors' technological pedagogical knowledge for integration of Innovative Teaching and Learning Technologies (ITLTs), based on 192 academicians from selected Tanzanian universities. The four technologically related dimensions of the TPACK model were considered. Descriptive statistics, one-way ANOVA and ordinal regression analysis were performed to analyze the influence of technological pedagogical knowledge on the integration of ITLTs while controlling demographic factors. The results demonstrate that the Technological Pedagogical Content Knowledge (TPCK) dimension is a statistically significant factor associated with the use of ITLTs ( $p < 0.05$ ). Amongst the control variables, age, ICT-competence, and gender were found to be significant factors influencing the use of ITLTs. Thus, this study recommends tremendous organizational support be put towards relevant capacity building among instructors for enhancing the integration of ITLTs.*

**Keywords:** Innovative teaching-learning technologies; Technological pedagogical knowledge; universities; instructors.

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## 1.0 INTRODUCTION

Technological changes and innovation are increasingly becoming influential forces in the education sector. This is because the rapid technological change is challenging education institutions to incorporate technologies in their curriculum and course delivery (Ertmer *et al.*, 2012). As such, these educational transformations have been important catalysts for most innovations when it comes to the teaching and learning processes in higher education as they provide invaluable help in improving the tasks a teacher is burdened with, streamlining the process of teaching-learning, and enriching the goals of education (Özdemir, 2017; Shavaz *et al.*, 2016). However, at numerous higher education institutions, the integration of innovative teaching and learning technologies has neither been fully recognised nor systematically used (Singh & Hardaker, 2014). As a result, the integration of innovative teaching and learning technologies in higher education remains a major challenge (Ilechukwu, 2013; Grimmer *et al.*, 2020); something which is particularly evident in developing countries, including Tanzania (Lashayo & Olahraga, 2017).

Currently, due to the tremendous increase of technological innovations being widely used in teaching and learning practices, perhaps the most significant question regards what the requirements for instructors are, to overcome the challenges related to the technology integration in teaching. Previous studies suggest that knowledge acquisition is an important

building stone that could facilitate effective and meaningful integration of technological innovations in teaching and learning for higher education (Scherer *et al.*, 2020; Jovica, 2019). In this, literature argued additionally that effective and meaningful integration of innovative teaching and learning technologies in higher education is highly influenced by the instructors' abilities and knowledge received. This further means that the instructor must be familiar with the technology and technological know-how in order to integrate technology into teaching-learning practices. According to Castéra *et al.* (2020), technological and technological-pedagogical knowledge enables instructors to select and utilise teaching-learning technologies in a pedagogically appropriate and effective manner. Despite the theoretical and empirical basis on what technological pedagogical knowledge can offer, the studies led by Atabek (2012) and Reborá (2016) have revealed that most instructors struggle to use or even do not use innovative teaching and learning technologies in a meaningful way.

While emerging educational research has mostly focused on technological pedagogical factors (Kihóza, 2016; Mtebe & Raphael, 2016; Scherer, 2021) to show either barriers or redesigning of the teaching tasks, nevertheless these studies are still limited to empirical evidence on the extent to which technological-pedagogical knowledge influence the integration of innovative teaching and learning technologies. To our knowledge, a number of such studies have been carried out in different national contexts, yet they have been limited when it comes to the investigation of technological-pedagogical knowledge as a prerequisite for the integration of ITLTs in the context of Tanzania. Therefore, it is an important contribution to educational change management, policies for integration of innovative teaching and learning technologies. This will also accelerate the tremendous initiatives of preparedness and

implementation of the technological change in Tanzanian universities. While building on previous studies, this study has focused on the instructors' technological-pedagogical knowledge needs and the extent to which they contribute to the integration of innovative teaching and learning technologies in selected Tanzanian universities.

Thus, the main research question that guided this study was: What technological pedagogical knowledge influence the instructors' integration of innovative teaching and learning technologies in the selected Tanzanian universities? The following were specific research questions examined: What are the instructors' technological pedagogical knowledge needs for the integration of teaching and learning technologies? What is the degree of using innovative teaching and learning technologies among instructors? To what extent the technological pedagogical knowledge among instructors influences integration of ITLTs?

## **2.0 LITERATURE REVIEW**

### **2.1 Preparedness for Change and Integration of Innovative Teaching-Learning Technologies**

Innovative Teaching and Learning Technologies refer to the recent electronic technologies utilized to support teaching and learning practices, as opposed to traditional methods of teaching and learning. These are technological changes in the education process that demand preparedness strategies to facilitate their effective integration. Instructors' preparedness for and readiness to accept change provide them with the ability to exert proactive effort toward their plan to integrate technological innovations and predict their behaviour towards change (Sharpe *et al.*, 2006). However, the preparedness for change assessment gap is normally revealed based on employee needs; for instance, the needs that enhance effective technological integration in the institutions involve identification of what is needed by an

individual to make the change (Lunenburg, 2010). In this, Atabek (2019) posits that if instructors' needs are not met, they could be the pitfall of successful integration of innovative technologies in education. Studies by Zhu (2010) and UNESCO (2021) demonstrate that the new roles instructors play due to educational transformations have brought about new 'needs' for them. This raises the question about what these requirements are. In that regard, previous research affirmed that technological pedagogical knowledge is an important need for instructors in the 21<sup>st</sup> century. Thus, an effective instructor needs to know how to integrate technology into teaching and learning practices (Niess, 2011; Benton-Borgh, 2013; Valtonen, 2019). According to Reborá (2016), the growth of knowledge in technological pedagogical factors indicates that instructors are more prepared to integrate innovative teaching and learning technologies. Therefore, integration of innovative teaching and learning technologies depends on the necessary knowledge acquired for technology integration.

## 2.2 Technological Pedagogical Knowledge and Integration of Innovative Teaching-Learning Technologies

Several studies reviewing the relationship between technological knowledge and the use of technology in education have yielded positive results. For example, Pierson (2001) and Okojie (2006) found that teachers with technological expertise are the most integrators of technology. Additionally, Qiao and Nan Wang (2011) reported that majority of instructors require technological knowledge and skills such as computing skills and familiarity on web design software and learning management system. Similarly, Zhu *et al.*(2013) assert that technological competences and knowledge are critical to integrating innovative technologies into teaching.

It has also been noted that most educators believed that successful integration of technology is not a task that

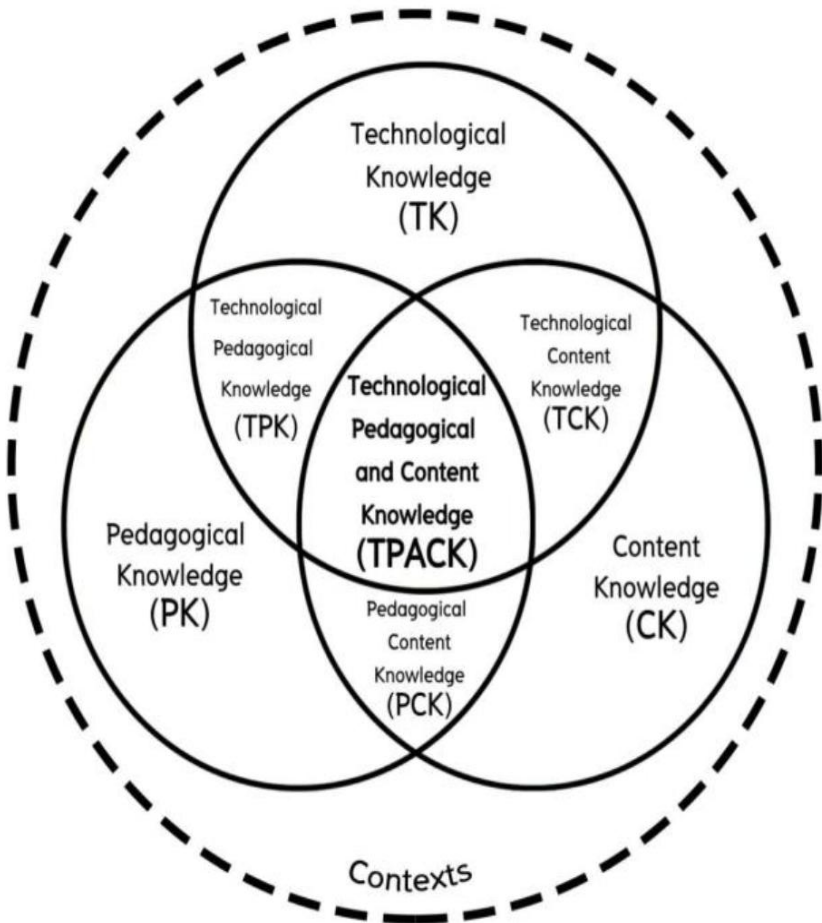
necessitates merely technological skills (Schmidt & Gurbo, 2008; Benson & Ward, 2013). For example, Schaik (2019) emphasizes that ICT itself does not necessarily lead into meaningful pedagogical practices. In addition, Voogt and McKenney (2017) posited that teachers should be enabled to select and utilise innovative teaching and learning technologies in pedagogically appropriate and effective ways. In particular, the pedagogical aspects regarding the integration of innovative teaching and learning technologies have been devoted to the consideration of the technologically relevant and meaningful use of innovative technologies as a component of teaching and learning practices. Much research has elucidated that engaging teachers in ICT courses directed towards specific pedagogical approaches might be desirable as this would raise their competencies for integrating innovative teaching and learning technologies.

A cumulative review of literature thus, suggests that technological-pedagogical knowledge represents teachers' understanding of how technologies might improve the teaching-learning process, and how teaching methods are to be aligned with the technological tool(s) (Koehler, *et al.*, 2014). As a matter of fact, higher learning institutions have been sluggish in their effective implementation of technological changes in teaching and learning with distinct perspectives that are either inappropriate for use or result in low usage. Occasionally, instructors who have heavily integrated ITLTs have also been criticized on how they use them. For example, studies by Kihocha (2016) and Almas, Machumu & Zhu (2021) concur with the former assertion while having identified a relatively low level of technological use in teaching activities among academicians in the Tanzanian context. There is, however, little evidence on how technological-pedagogical knowledge influences the integration of innovative teaching and learning in Tanzanian higher

education.

### **2.3 The Study Model**

This empirical study apprehends technological pedagogical knowledge constructs for integrating innovative teaching and learning technologies from the Technological Pedagogical Content Knowledge (TPACK) model. The model is useful for measuring the knowledge needed for effective and meaningful integration of technology into the teaching and learning practices. It proposes that effective teaching and learning with technology requires the three core knowledge components: Technological Knowledge, Pedagogical Knowledge, and Content Knowledge. The interaction among these three TPACK - components constitutes the additional elements such as Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Pedagogical Content Knowledge (TPCK). Figure 1 is illustrative.



**Figure 1: TPACK Framework**

**Source:** Adopted from Koehler & Mishra (2013).



A study conducted by Mtebe (2018) suggested that TK, TCK, TPK and TPCK correspond directly to the technological pedagogical knowledge. Similarly, Kafyulilo *et al.* (2019) reported sufficient knowledge related to CK, PK, and PCK among instructors in Tanzania. In this, however, such studies also found that instructors are limited to TK, TPK, TCK and TPCK knowledge dimensions. Therefore, this study adopts the Technological Pedagogical Content Knowledge framework with the predominantly focus on the four technology (T)-related components, which are TK, TPK, TCK and TPCK.

As modified from the explanation by Koehler and Mishra (2007), the four explored elements are described hereunder:

Technology Knowledge (TK) refers to the teachers' understanding of the possibilities and constraints of certain technology; and the skills to utilize technologies efficiently in their teaching and learning practices.

Technological Content Knowledge (TCK) refers to teachers' knowledge about the technologies used within the content area. Teachers need to know not just the subject they teach, but also the way the subject may be altered through the application of technology.

Technological Pedagogical Knowledge (TPK) is an understanding of the nature of teaching and learning with technology; and of the benefits and disadvantages of various technologies for a certain pedagogical practice.

Technological Pedagogical Content Knowledge (TPCK) is an understanding that emerges from interactions among content, pedagogy and technology knowledge.

### **3.0 METHODOLOGY**

#### **3.1 Research Design and Data Collection Procedures**

This is a cross-sectional study design in which the data was collected from public universities in Tanzania through the use of

a survey. Specifically, the study is confined to instructors at Mzumbe University and the University of Dodoma whereby data was collected through both web-based and paper-based questionnaires. The link to the survey was disseminated via emails and WhatsApp groups of academic members of staff. The aim of the research was explained to the academic staff prior to any kind of distribution of the survey. Participants could take the survey voluntarily while anonymity was assured for all participants. A total number of 200 paper-based surveys were distributed to the academic members of staff, of which 135 were returned. Meanwhile, only 72 respondents responded to the survey via the shared link, whereby 207 surveys were returned. Among the 207 surveys, 15 surveys were excluded during the data cleaning process due to a variety of reasons including extreme outliers and accomplishments, thus 192 surveys were finally used for subsequent analysis.

### 3.2 Instruments and Scale of Measurements

We employed a Technological Pedagogical Knowledge Survey (TPKNS) questionnaire modified based on Mishra and Koehler (2006) to investigate the academic staff members' technological pedagogical knowledge. The model consists of four (4) dimensions: Technological Knowledge-TK (four items), Technological-Pedagogical Knowledge-TPK (four items), Technological Content Knowledge-TCK (three items), and Technological Pedagogical Content Knowledge-TPCK (four items) based on a five-point scoring scale ranging from 1(strongly disagree) to 5(strongly agree). Thus, the instrument had 15 items.

In addition, the Integration of Innovative Teaching and Learning Technologies Survey (IITLTsS) was self-revised with 22 corresponding teaching and learning technological tools. The integration of IITLTs was measured mainly using four sub-scales

revolving around the use of various teaching and learning technological tools related to online interactions and technological competency based on the work of Aslan & Zhu (2016) and John (2015). The ratings provided ranged from the never used (1) to always used (5), then were transformed to response options of: frequently used, rarely used, and never used, coded as 3, 2, and 1, respectively. The Cronbach's alpha of the instrument was found to be 0.9, which is considered highly reliable.

### 3.3 Data Analysis

To determine the reliability of the research instrument, we pre-tested the tool using 30 respondents from the university which hold almost similar qualifications with the universities under study, was not included in the sample. The Spearman-Brown split -half Cronbach's alpha was conducted to test whether the tool was reliable prior to the main data collection; and it was found to be reliable with a 0.9 Cronbach's alpha. Descriptive analysis such as frequencies, means and percentages were employed. One Way Analysis of Variance (ANOVA) was used to determine the significance of the means of the 'Technological Pedagogical dimensions' whereby the Duncan multiple range test was conducted to separate the differences of the means. The model's goodness of fit was assessed by performing the assumptions of independent observations, normality check and the Levene's test for equal variance.

Thereafter, in determining the average frequency (degree) of integration of ITLTs, a Likert scale ranging from never used (1) to always used (5) was employed, with the answers then recorded as 0, 1, 2 and 3 for never used, rarely, frequency and always, respectively. We derived the index from the 5-point Likert scale ranging from 0 to 4 and the mean scores, which further assisted in performing "the mean cut-off point". The

response values were added to obtain 10, which was divided by 5 to get a mean score of 2.0. ( $4+3+2+1+0= 10/5 = 2$ ). Mean scores (the mean cut off point) of 2.0 or above were classified as most often used, while scores less than 2.0 were regarded as otherwise. Then, the total score for use of ITLTs was calculated by summing up the individual scores for all 22 statements regarding the use of technologies. Therefore, the total scores for the use of ITLTs ranged from 0 to 4. The higher values indicated a higher use or integration of technologies in teaching-learning, while low values indicated low technology integration in teaching-learning. Therefore, 2 was the cut-off point and stood for medium. Hence,  $< 2$  scores on the overall average scores were low use, while  $> 2$  stood for high usage.

Lastly, we determined the relationship between technological pedagogical knowledge needs and integration of ITLTs using ordinal regression analysis. In this model, we tested whether technological pedagogical knowledge needs have an influence on the integration of ITLTs while including other confounding variables of interest such as ICT competence, age (in years), gender (1=male, 0=female) and academic position (1=Tutorials, 2-Assistant lecturer, 3-Lectuer,4-Senior Lecturer, 5-Associate professor, 6-Professor), prior knowledge on ITLTs (1=have knowledge, 0=do not have), and ICT competence (2 = High, 1 = Medium, 0 = Low). Thus,

$$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \dots + \beta_{10}X_{10} + \varepsilon$$

Whereby Y= (level of integration of ITLTs); while  $b_1$  to  $b_{10}$  = coefficients of the independent variables, and  $X_1$  to  $X_{10}$  = independent variables entered into the ordinal regression model.

Concerning the technological-pedagogical knowledge dimensions, Confirmatory Factor Analysis (CFA) indicates a good fit between the variables of interests. The CFA shows that

the ratio of the minimum discrepancy to the degree of freedom (CMIN/DF) was 1.41 (recommended), which is less than 3 at  $p < 0.05$ . The other Goodness of Fit (GOF) indices comprise GFI= 0.92; AGFI=0.85; NFI=0.954; ECVI=0.99; TLI=0.98; CFI=0.98; RMSEA=0.047 (PCLOSE=0.595); FMIN=0.63; RMR =0.03 and PRATIO=0.81. The reliability of the scales was acceptable, with Cronbach's alpha coefficients range between 0.792 and 0.891.

### 3.4 Participants

A random sample of 192 academic members of staff was involved in this study. To confirm the justifiable sample size for the study, the number of variables modeled in the analysis was used, following the rule of thumb for conducting a sound quantitative analysis, which is to say that each variable in a model must have at least 15 respondents. That means the eleven (11) dimensions within the model were multiplied by 15 to obtain 165 respondents, thus a sample size of 192 was found to be viable and valid for this study. The respondents hailed from various faculties/schools covering the disciplines of social sciences, law, science and technology, education, and business. In the process, age and gender balance were also expected to be taken into consideration, although the female population was found to be low among academic staff members at the two universities. In particular, among academic staff participants, only 36.5% were female. The average age of the respondents was 39.97, and the demographic characteristics of the sample are presented in Table 1 below.

**Table 1:** Demographic Information of the respondents

	Mean	Categories	F	%
Age	39 .9 7			
Working	10			

experience	.5 2		
Gender	F	70	36.5
	M	12 2	63.5
Academic position	Tutorial assistants	14	7.3
	Assistant lecturers	80	41.7
	Lecturers	71	37.0
	Senior lecturers	21	10.9
	Associate Professors	4	2.1
	Professors	2	1.0
ITLTs Prior knowledge	Yes	15	81.7
	<i>Training</i>	97	50.5
	<i>Self-learning</i>	82	42.7
	<i>Colleagues</i>	33	17.2
	No ITLTs prior knowledge	35	18.2

## 4.0 RESULTS

### 4.1 Technological Pedagogical Knowledge among Instructors

The results presented in Table 2 depict the mean scores for the technological pedagogical knowledge dimensions among academic staff members of the selected Tanzanian universities. The results indicate that Technological Pedagogical Content Knowledge (TPCK) among academic staff members was found to have a statistically significant lower mean score of 2.56 (SD=0.80) than the other technological pedagogical knowledge dimensions. In contrast, the average score for Technological Knowledge (TK) was found to be statistically higher (M=2.86; SD=0.78) than the other dimensions, which further implies that

the participants are highly in need of Technological Pedagogical Content Knowledge (TPCK), whilst less in need of Technological Knowledge. The results generally suggest a relatively high perceived need for technological pedagogical knowledge among the participants.

Table 2: Mean and SD of the Technological Pedagogical knowledge

Dimensions	Mean	SD
Technological Content Knowledge (TCK)	2.64 <sup>b</sup>	0.74
Technological Pedagogical Knowledge (TPK)	2.62 <sup>b</sup>	0.79
Technological Knowledge (TK)	2.86 <sup>a</sup>	0.78
Technological Pedagogical Content Knowledge (TPCK)	2.56 <sup>b</sup>	0.80

NB: Means with different superscripts are significantly different at  $p < 0.05$ ; M=Mean; SD=Standard deviation.

#### 4.2 Degree of using innovative teaching and learning technologies

The results depicted in Table 3 reveal that more than half (63.5%) of the academic staff had a low frequency of ITLT use, while 34.4% (n=66) were found to have a highly frequent use of ITLTs in their teaching and learning practices. Furthermore, the results reveal that only a few (2.1% (n=4)) had a moderate frequency of ITLT use. Generally, these results further demonstrate the relatively limited use or integration of innovative teaching and learning technologies among academic staff members with an average of 1.87 (SD=0.72) as determined by the ‘mean cut-off point’.

Table 3: Degree of Using Innovative Teaching and Learning Technologies among Academic Staff Members

Categories	F	%
Low	122	63.5
Medium	4	2.1
High	66	34.4

### 4.3 Extent of Technological Pedagogical Knowledge on Integration of ITLTs

Table 4 displays an ordinal regression model of the technological pedagogical knowledge dimensions influencing the integration of innovative teaching and learning technologies among academic staff members controlled for age, prior knowledge, gender, and ICT competence. The assumptions of ordinal regression model were tested, first by using the proportional odds assumptions (specifically the parallel lines regression assumptions) in order to check for the validity of the model. The elucidated results exhibit a non-significance of the Chi-Square statistic, which indicates that there is no violation of the test of proportional odds assumptions. Therefore, the model was found to be valid for this data set.

Besides the parallel lines assumption, it was also revealed that the -2 log-likelihood improved from 1092.208 for the model with an intercept only to 829.125 with explanatory variables. This implied that the addition of the explanatory variables explained more of the variance in the outcome. Additionally, the Chi-square value was 263.08 with a df (degree of freedom) of 11; and was highly statistically significant at  $p \leq 0.01$ , indicating that the independent variables influenced the dependent variable. Furthermore, the McFadden, Nierkerk  $R^2$  and Cox and Snell  $R^2$  and values in the model were 0.241, 0.750, and 0.784, respectively. This implied that the predictors in the model accounted for at least 24.1-to-78.4% of the integration of innovative teaching and learning technologies. Lastly, Pearson's and the deviance chi-square statistics for the model were performed to determine whether the model is a good fit for the data. The yielded results demonstrate that the p value is not significant, thus implying that the observed data is consistent with the fitted model, which means the model clearly fits the data well.



Moreover, the ordinal regression results indicate that the significance of the test for age in years is less than 0.05, suggesting that its observed effect is not due to chance. Since its coefficient is positive, as age increases, so too does the probability of not being in one of the higher categories of account status.

Gender also seems to be an important predictor on empirical grounds: the odds ratio for males is 23.78, which implies that the odds of being at a higher level for males is 23.78 times that of female respondents, holding all other variables constant. This means that males are more likely to be higher users of ITLTs than females.

Prior knowledge on ITLTs had an estimated beta coefficient of 2.142 [Wald, 8.52]; and the variable was statistically significant ( $p < 0.01$ ). This means that participants with prior knowledge of ITLTs had an 8.53 percent higher likelihood of integrating/using ITLTs than those who do not have such prior knowledge.

Furthermore, the findings suggest that ICT competence (prior knowledge of ITLTs) is a statistically significant factor positively correlated with the integration of ITLTs at  $p < 0.01$ . The odds of being a user of ITLTs have been noted to be highly influenced by having either a high or medium ICT competence. The results found a predicted increase of 3.118 and 2.126 with high competence and medium competence respectively compared to those with low competence for the integration of ITLTs.

Moreover, the results revealed that TPCK was a significant positive predictor of ITLTs use, which implies that for every one unit increase in TPCK score, there is a predicted increase of 0.989 in the odds of being at a higher level on ITLTs use. More generally, this indicates that there is an increased likelihood of

falling at a greater level of ITLTs use as values rise on an TPCK. However, the results of this study did not reveal a significant association between other perceived technological pedagogical knowledge dimensions such as TK, TCK and TPK.

Table 4: The Influence of Technological Pedagogical Knowledge Dimensions, Control Variable on Integration of ITLTs

Variable	Estimate	Std. Error	Wald	df
TK	.164	.289	.321	1
TPK	.414	.361	1.313	1
TCK	.098	.225	.188	1
TPCK	.989	.351	7.922	1
Age	-.011	.034	.110	1
Academic position	-.045	.247	.034	1
Working experience	-.014	.044	.098	1
Prior knowledge (Reference those that do not have any)	2.142	.721	8.823	1
Gender (Male) (Reference female)	1.169	.601	27.842	1
[Competence_ordinal=High] (Reference Low)	3.118	.689	20.460	1
[Competence_Medium] (Reference low)	2.126	.955	4.961	1

\*\* $\rho < 0.01$ ; \* $\rho < 0.05$

## **5.0 DISCUSSION**

This study sought to examine instructors' technological-pedagogical knowledge needs and their influence on the integration of innovative teaching and learning technologies when controlling age, academic position, working experience, prior knowledge of ITLTs, gender, and ICT-competence. That being the case, this section has recorded the crucial statistically significant results which are discussed thereafter.

The results of mean scores among technological pedagogical knowledge suggest that the Technological Knowledge dimension (TK), owns a significantly higher mean score than other dimensions. The results presuppose that the academic staff possess somewhat sufficient technological knowledge for the integration of ITLTs in their teaching and learning practices. This is in contrast with the study by Kafyulilo (2019), who posits that instructors lack technological- knowledge for integrating technologies in teaching. In other terms, these results can be further associated with the instructors' struggles to possess the technological skills for handling the rapid pace of technological change using various initiatives, including self-learning. Consequently, engagement of self-online learning could facilitate an increase of technological knowledge and skills for integrating ITLTs in their teaching and learning practices. It is currently common globally to adopt self-regulated online learning to solve ITLTs technical problems among different groups of people in various sectors, one being education (Cheng, 2011; Tyler-Wood, 2018).

The results also revealed relatively high need for Technological-Pedagogical Content Knowledge (TPCK) among instructors. This further implies that majority of instructors do not possess

the technological pedagogical content knowledge, which is an important aspect for effective and appropriate integration of ITLTs. A possible explanation for these results is that most academic staff members are perhaps not conversant with application of technological knowledge, especially in developing and cultivating meaningful and effective ways of using innovative teaching and learning technologies in their teaching and learning practices. This adds to the views of Atabek (2012) and Reborá (2019), who argued that most instructors continue to struggle to incorporate innovative teaching and learning technologies in a meaningful manner.

Furthermore, the results evidence the relatively low average use of ITLTs among members of academic staff. This further signifies that the degree of using ITLTs in teaching-learning practices is low among academic staff members. This finding attracts our attention as with the fast-moving pace of technology use, higher education must be technologically relevant. That means academic staff members should determine the technological facets necessary to facilitate the use of ITLTs. The results infer with the most recent studies on the integration of ITLTs since COVID-19 resulted in an increased use of online teaching and learning globally (Tondeur *et al.*, 2020).

The findings further reveal that the age coefficient is significantly negative. This implies that as age increases, so does the probability of not being in one of the higher categories of account status. This further implies that older participants are relatively frequently reluctant to integrate innovative teaching and learning technologies compared to earlier career- academic staff. Previous studies indicate that older teachers are less likely to adopt the integration of ICTs in teaching; and may require more time to adjust to recent technological changes than younger ones (Barman, 2011; Ke and Kwak, 2013; Castera,

2020).

The results further suggest gender as a dependent factor for the integration of ITLTs among instructors. It was found that being a male instructor increases the likelihood for a person to integrate the ITLTs into their teaching compared to females. This further calls for female instructors to take more initiatives to enhance their integration of innovative teaching and learning technologies in their teaching and learning practices. Similar results were found by Yesemin (2018), who also revealed that males are more confident and receptive to technological changes than females.

Moreover, only technological pedagogical content knowledge (TPCK) indicates a significant positive coefficient among the studied technological pedagogical dimensions. This indicates that the odds of being in a higher level on ITLTs use increases by a factor of 0.98 for every one-unit increase in TPCK. This further signifies that TPCK is an important factor that could enhance the use and meaningful integration of ITLTs among academic staff members. The results confirm the argument that learning about a certain technology can be easier than using it in a meaningful way contextually (Atabek, 2019). However, the results did not establish a significant influence of the other dimensions such as TK, TPK, TCK, working experience and academic position on the integration of ITLTs, although the results indicated a positive relationship.

## **6.0 CONCLUSION**

Generally, the results indicate a significant influence of Technological Pedagogical Content Knowledge (TPCK) on the integration of innovative teaching and learning technologies

among instructors when controlled for age, gender, ICT competence and prior knowledge of ITLTs. This signifies that technological pedagogical content knowledge (TPCK) is an important component which is highly needed by instructors for effective and meaningful integration of innovative teaching and learning technologies in Tanzanian universities. That is, it is crucial for instructors to possess and innately familiarise with it in order to ensure effective and meaningful integration of innovative teaching and learning technologies in higher education. While this study ascertains tremendous initiatives in the integration of ITLTs in Tanzanian universities, we highly recommend that instructors' characteristics such as ICT competence, age, gender, and TPCK should be taken into consideration for effective and meaningful integration of ITLTs.

In addition, relevant technological pedagogical knowledge among instructors will accelerate the enormous efforts of preparedness and implementation for change in technology integration in Tanzanian universities. Firstly, by identifying and imparting required knowledge for the integration of ITLTs. Then, we expect that will facilitate relevant capacity building and thus increase the competence of instructors, which could eliminate the challenges related to the integration of ITLTs. However, this current study assesses technological pedagogical knowledge need among instructors only by using the related dimensions of TPCK. Future studies may consider other technological pedagogical variables of different frameworks. We further believe that there is really a need to conduct even an experimental study in the future.

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