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Mastering the digital frontier: Development of pedagogical use of ICT competences among student-teachers in Tanzania

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Abstract

This study investigated the factors influencing student-teachers' development and use of pedagogical ICT competences in teaching and learning process. The study was guided by the Theory of Planned Behavior and the Technological Pedagogical Content Knowledge model. A descriptive research method was employed to gather quantitative data from a purposive sample of 187 third-year student-teachers from three universities in Tanzania. Data analysis included descriptive statistics and correlation analysis. The results indicated a significant positive correlation between variables related to facilitative condition factors for the development of pedagogical ICT competences. Other factors such as attitudes and expectations, operational usefulness, and social influences had positive corrections; although, they were statistically insignificant. Regarding perceived pedagogical ICT competences related to content delivery, about 74% of the respondents perceived themselves as very skilled and 25.67% as fairly skilled. In addition, competences related to incorporating ICT in instructional strategies, 58.82% of the respondents reported that they were very skilled and 34.22% said they were fairly skilled. These findings highlight the need for targeted interventions to strengthen the training on pedagogical ICT competences and promote effective technology integration in content delivery and instructional strategies.

Keywords: Digital competences, Pedagogical ICT competences, Student- teachers, Technology integration, Teacher training

Introduction

In the contemporary digitally enabled landscape, Information and Communication Technology (ICT) has the potential to transform the nature of socio-economic interactions (Hawamdeh & Abdelhafid, 2024; Starkey, 2020; UNESCO, 2018). In Tanzania, the National ICT Policy (NICT) explicitly highlights the pivotal role of ICT in social and economic development (United Republic of Tanzania [URT], 2023). The effective use of digital technologies and solutions is also considered as important

catalysts for making Tanzania a learning society. The policy further highlights the urgent need of ICT competences development in the Tanzanian workforce through the formal education system (URT, 2023). However, among other factors the realisation of these policy assumptions is hindered by the inadequate pedagogical ICT competences among teachers (Ministry of Education, Science and Technology [MoEST], 2024).

In education, ICT plays a crucial role in enhancing pedagogical practices and enabling teachers and students to perform more effectively (MoEST, 2024; Starkey, 2020; URT, 2023). Similar to other countries, the integration of ICT in education in Tanzania is viewed as a key catalyst for improving the quality of education, particularly in teaching and learning (MoEST, 2024; URT, 2015; URT, 2023). Specifically, Tanzanian Education and Training Policy (ETP) 2014, as revised in 2023 (URT,2023) emphasises that ICT should be integrated into pedagogical practices at all levels of education. In practices, teachers are responsible for integrating ICT into pedagogical practices. Due to insufficient competences, teachers often face challenges in integrating ICT into pedagogical practices in ways that improve learning outcomes (Mtebe et al., 2021; Ngao & Xiaohong, 2020). This lack of necessary competences in using ICT tools and resources hinders their ability to integrate ICT into their pedagogical practices (Howard et al., 2021; Mtebe et al., 2021). Consequently, teachers may rely on traditional teaching methods, hence missing opportunities to engage students with innovative and technology-driven approaches.

Effective ICT integration into education, particularly in pedagogical practice, requires teachers to develop a specific set of competences and knowledge (Starkey, 2020; URT, 2015). The 2015 Tanzania ICT Competency Framework for Teachers emphasises the need for teachers to develop ICT competences relevant to their roles (URT, 2015). Teachers' role related to pedagogical use of ICT competences includes; aligning appropriate ICT tools with instructional strategies, creating engaging learning experiences and enhancing an environment where students use ICT effectively (Farjon et al., 2019; UNESCO, 2018; URT, 2015). In this regard, training teachers with pedagogical ICT competences is increasingly becoming an important consideration of teachers' qualifications. In addition, it is considered a strategic entry point in preparing aspiring teachers who can use emerging educational technologies in their future classrooms (Howard et al., 2021; Ngao & Xiaohong, 2020). As we stand on the precipice of the digital frontier, it becomes imperative to equip tomorrow's teachers with the adequate digital skills including pedagogical ICT competences (Ndibalema, 2019; Reisoğlu & Çebi, 2020; UNESCO, 2018).

Pedagogical ICT competences has been described as a set of related knowledge, skills, and attitudes that enable teachers to effectively integrate ICT tools and resources into teaching and learning practices (Silva et al., 2019; Starkey, 2020). It entails such knowledge and skills related to matching Internet resources with specific curriculum standards, using learning management systems, developing lesson plans that incorporate ICT-supported activities, and devising ICT in the assessment and

evaluation of student learning (McGarr & McDonagh, 2019; Starkey, 2020; UNESCO, 2018). Pedagogy, which is the art and science of teaching, is intrinsically linked to the process of knowledge creation, fostering critical thinking, and nurturing holistic development in learners (Shah & Campus, 2021). Moreover, technology serves as a catalyst, amplifying the reach and efficacy of pedagogical practices (Hawamdeh & Abdelhafid, 2024; UNESCO, 2018).

Despite the increasing access to educational technologies and their potential in pedagogical practices, student-teachers reported that they are inadequately prepared to spearhead the transformative pedagogical use of ICT competences (Ndibalema, 2019: Zarei & Mohammadi, 2022). In addition, a significant number of teachers at various levels of education express feelings of inadequacy and unpreparedness when it comes to the application of ICT competences in teaching and learning (Mtebe et al., 2021; Organisation for Economic Co-operation and Development [OECD], 2019). In addition, it has been noted that newly qualified teachers use ICT mainly at a minimum level of knowledge acquisition (Tran et al., 2020) rather than bringing about fundamental pedagogical transformations. According to the 2018 Teaching and Learning Survey (TALIS), more than 50% of the teachers reported that they were not well prepared to use ICT as a pedagogical tool (OECD, 2019).In addition, the same study revealed that 44% of teachers in 31 Asian countries reported that ICT use for teaching was not included in their teacher training (OECD, 2019).Therefore, efforts to develop the pedagogical use of ICT competences often lag behind the actual needs of practising teachers' classroom prerequisites.

The Current Study

The development of pedagogical ICT competences to aspiring teachers assume paramount significance (MoEST, 2024; UNESCO, 2018; URT, 2015). Within this context, student-teachers have emerged as pivotal and potential transformative agents in the educational ecosystem poised to shape the future of learning. These aspiring teachers represent the vanguard of change, tasked with the responsibility of teaching, nurturing 21st century skills, and instilling love for digitally enabled lifelong learning among learners (Hawamdeh & Abdelhafid, 2024; Tondeur et al., 2019). However, to fulfil this noble mandate in the digital age, they must be adequately equipped with the requisite skills and competences to leverage technology as a catalyst for educational transformation (OECD, 2019; Starkey, 2020; UNESCO, 2018).

Despite the growing importance of ICT competences in education, there remains a notable gap in the literature regarding the specific factors that influence the development of these competences among student- teachers, particularly in the pedagogical context. Existing studies often overlook the nuanced interplay between personal and contextual factors that shape how student-teachers acquire and apply pedagogical ICT competences. This underscores the need for further investigation into these under-explored areas to better understand how to effectively support the integration of ICT in education. This study investigated the factors influencing

student-teachers' development and use of pedagogical ICT competences in teaching and learning process. The study specifically examines the factors that shape student-teachers' perceptions of developing pedagogical ICT competences, focusing on current training practices and perceived competencies.

The study attempts to widen our understanding of the factors influencing the development of pedagogical ICT competences among student-teachers. Understanding these factors in the Tanzanian context is crucial for ensuring that teacher education is responsive to the local needs and challenges (URT, 2015). This could further contribute to technology-enhanced pedagogical transformation. Moreover, understanding student-teachers' self-reported abilities in application of ICT competences in teaching and learning could help to identify areas where they feel confident and areas where they might need additional support or training. This could also tailor teacher training programmes to address specific knowledge gap. In this respect, the study focused on the following lines of enquiry: (1) What are student-teachers' perceptions on the factors influencing the development of pedagogical ICT competences? (2) What are the student-teachers' perceived pedagogical ICT competences related to content delivery and instructional strategies?

Theoretical Considerations

This study employed the Ajzen's (1991) Theory of Planned Behaviour (TPB) to investigate factors influencing the development of pedagogical ICT competences among student-teachers. TPB describes the interconnectedness of motivational factors in forecasting an individual's intention to perform specific behaviour within a specific context (Ajzen, 1991). The central premise of TPB is behaviour intentions. Behaviour intentions refer to the tendency and expected level of action which shows that individuals desire to engage in performing a specific behaviour (Ajzen, 1991; Şimşek & Ateş, 2022). In the present study, behaviour intentions are linked to factors influencing student-teachers' desire to engage in the process of developing pedagogical ICT competences.

The relevance of TPB in the present study lies in the ability of student-teachers to make rational decisions regarding their desire to engage in developing their pedagogical ICT competences. According to the TPB, human beings are rational decision makers (Ajzen, 1991; Kan & Fabrigar, 2020). The premise of TPB is that human behavioural intention is determined by three constructs: attitudes and disposition (behavioural beliefs), subjective norms (normative beliefs), and behaviour control (control beliefs). These three constructs were used in this study to understand the personal and social factors that predict student-teachers' intentions to engage in the process of development and use of pedagogical ICT competences.

Firstly, the attitude construct is a personal factor referring to constructive or negative dispositions towards performing a specific behaviour (Kan & Fabrigar, 2020; Legros & Cislaghi, 2019). In the context of acquiring pedagogical ICT competences, student-teachers' behavioural beliefs towards the application of ICT competences in

teaching and learning can significantly influence their behavioural intention to acquire and use such competences (Rudhumbu et al., 2021). Scholars including Tondeur et al. (2019) and Twillert et al. (2020) contend that students' attitudes towards ICT are significant factors in predicting their technology uptake in teaching and learning. In contrast, Şimşek and Ateş (2022) established that students' perceived attitudes towards technology have indirect effects and do not warrant them to use Web 2. technologies in their courses. This divergence in findings raises questions about the complexity of the relationship between attitudes and ICT acceptance. It suggests that while attitudes may play a role, other factors related to subjective norms and behaviour control might also be critical (Cabellos et al., 2024; Legros & Cislaghi, 2019; Şimşek & Ateş',2022).

Secondly, subjective norms refer to the perceived social pressure an individual feels to perform or not perform a particular behaviour (Tondeur et al., 2019; van Twillert et al., 2020). It highlights how an individual perceives the influence and significance of others' expectations. In the context of the present study, these are social factors pertaining to the influence of student-teachers' perceptions of peers, lecturers, and other key individuals on their ability related to ICT acceptance in teaching and learning (Kan & Fabrigar, 2020). It is assumed that social and professional expectations around the importance of pedagogical use of ICT competences may motivate student-teachers to intentionally acquire these competences (van Twillert et al., 2020). Şimşek and Ateş' (2022) study informed that subjective norms were among the key factors predicting learning about pedagogical ICT competences. In this study, factors related to subjective norms were explored to ascertain the influence of social-related factors on the development of pedagogical ICT competences among student-teachers.

The third category of factors examined in this study is perceived behaviour control. According to Legros and Cislaghi (2019), perceived behaviour control includes personal assessments of resource availability and self-efficacy regarding one's competence to perform a desired behaviour. This concept encompasses both internal and external factors that influence how easy or difficult it is to perform a behaviour (Kan & Fabrigar, 2020). When it comes to acquisition of pedagogical ICT competences, factors like prior ICT knowledge, experience, supportive conditions, and effort expectancy play a key role (Cabellos et al., 2024; Tondeur et al., 2019). Onyeji and Victor-Ishikaku (2023) argue that learning is inherently tied to the activities, contexts, and cultures in which it takes place. In Tanzania, as in other developing countries, there is a shortage of essential facilitative conditions needed to integrate ICT into both teaching practices and the overall school organisation (Mtebe et al., 2021; Vo, 2019). This lack of resources raises questions about how student-teachers can be effectively prepared for innovative ICT use in teaching within such challenging environments (MoEST, 2024).

In addition, research suggests that students' prior ICT experience significantly impacts their ability to integrate technology (Farjon et al., 2019; Steele, 2019). This indicates that student-teachers' pre-training in ICT experiences can influence their

development of pedagogical ICT competences. In Tanzania, the limited use of ICT in secondary school may negatively affect student-teachers' prior ICT experiences related to pedagogy (MoEST, 2024).

Scholars have used the Theory of Planned Behaviour (TPB) to explore technology acceptance in education, yielding varied results on its influence on explaining student-teachers' technology acceptance (Kan & Fabrigar, 2020; Şimşek & Ateş, 2022; Tondeur et al., 2019; van Twillert et al., 2020). van Twillert et al. (2020) found that attitudes towards ICT use had the most significant impact on students' intentions, while Cabellos et al. (2024), and Şimşek and Ateş (2022) highlights the importance of subjective norms on technology acceptance. In this study, the Theory of Planned Behavior (TPB) is systematically applied to examine the factors influencing student-teachers' behavioural intentions to develop their pedagogical ICT competences.

TPACK and Pedagogical ICT competences

The demand for teachers with pedagogical ICT competences is ever-increasing, and is considered a key quality of teachers (Miguel-Revilla et al., 2020; UNESCO, 2018; URT, 2015). Influenced by establishing nuanced understanding on how technology intersects with pedagogical strategies and content knowledge, Mishra and Koehler (2006) proposed the TPACK model. TPACK includes technology as a third domain of teacher knowledge, along with pedagogy and content. This model integrates technological knowledge (TK) with pedagogical knowledge (TK) and content knowledge (CK). The model reflects the basic elements of the interconnectedness of technology, pedagogy, and content (McGarr & McDonagh, 2019). Ideally, these TPACK elements were expected to be simultaneously integrated in the development of teachers' pedagogical ICT competences (Mishra & Koehler, 2006). According to Mishra and Koehler (2006), the pedagogical use of ICT is mostly linked with teachers' ability to integrate ICT in content delivery (technological content knowledge) and instructional practices (technological pedagogical knowledge). The fusion of technology, pedagogy, and subject matter represents a potent synergy that has the potential to revolutionise not only pedagogical processes, but also learning outcomes (McGarr & McDonagh, 2019; Mishra & Koehler, 2006).

However, despite the perceived importance of the seamlessness of TPACK, effective teacher preparation in this context seems to be lacking. Student- teachers often do not feel adequately prepared to effectively integrate technology into pedagogy and subject matter (McGarr & McDonagh, 2019). The most effective way to develop student-teachers' pedagogical ICT competences is to provide them with authentic technology integration experiences as a core component of their training (Farjon et al., 2019; Howard et al., 2021). Authentic technology integration is beyond learning technology for the sake of it, since it requires integrating ICT with the subject matter that enhances engagement and application of knowledge in the practical context (Mishra & Koehler, 2006; UNESCO,2018). However, in most cases, in practice, teacher education training, and educational technology courses are taught as stand-alone

courses, separate from teaching subjects and methodology courses (Kimm et al., 2020). Such an approach is likely to yield a gap between ICT generic competences and pedagogical ICT competences (McGarr & McDonagh, 2019). This has been revealed by Ngao and Xiaohong (2020) that in Tanzania, technological, pedagogical, and content knowledge are not fully infused in teacher education programmes. In addition, ICT integration in teaching and learning has been criticised for limited opportunities for collaborative and practical experiences (MoEST, 2024; Ngao & Xiaohong, 2020). Unfortunately, this may lead to the accumulation of generic ICT competences without any consideration of pedagogical use of these competences.

Research Methods

This study employed a descriptive cross-sectional research method to investigate the factors influencing the development of ICT competences among undergraduate student-teachers and their perceived use of pedagogical ICT competences. The study employed purposive sampling to select study sites and respondents that aligned with its objectives (Campbell et al., 2020). Three universities offering undergraduate teacher education programs with specific technology or educational technology courses were selected to investigate the factors influencing student-teachers' perceptions of developing and using ICT pedagogically. Furthermore, it was assumed that each university would represent a unique educational context that offers insights into diverse pedagogical approaches, institutional resources, and student demographics. Third-year student-teachers were purposively chosen due to their familiarity with the study context, assuming they had already learned application of ICT competences in teaching and learning. During data collection, a total survey technique was used. According to Häder (2022), total survey technique involves administering a survey tool to all available prospective respondents. The survey involved all student-teachers from the selected degree programmes, who were available during the scheduled data collection, as the number of targeted respondents was relatively small (fewer than 250 participants). Based on these sampling procedures and criteria, a total of 187 final-year student teachers participated in this study (see Table 1).

Table 1: Demographic Characteristics of the Respondents

		Male		Female		Total	
Variables		N	%	N	%	N	%
University (Study Sites)	University- A	69	36.9	10	5.3	79	42.2
	University- B	45	24.1	16	8.6	61	32.6
	University -C	32	17.1	15	8.0	47	25.1
	Subtotal	**146**	**78.1**	**41**	**21.9**	**187**	**100.0**
Age group	1980-1989	16	8.6	4	2.1	20	10.7
	1990-1999	130	69.5	36	19.3	166	88.8
	2000-2009	0	0.0	1	0.5	1	0.5
	Subtotal	**146**	**78.1**	**41**	**21.9**	**187**	**100.0**

Source: Field Data

A survey was employed to collect quantitative data using a self-developed close-ended questionnaire which was developed following the analysis of literature (Jin, 2019; Vo, 2019) and modification of items from existing questionnaires to suit the context of the present study. Furthermore, the process of developing the questionnaire was enriched with attributes associated with the integration of ICT in teaching and learning, as stipulated in ICT integration models in teaching and learning (Mishra & Koehler, 2006). The theoretical constructs from the Theory of Planned Behavior (Ajzen, 1991) served as the conceptual foundation for this study and informed the development of the questionnaire. The mode of assessment of the questionnaire was based on a four-point Likert scale. Unlike five- or seven-point (odd response) scales, a four-point (even response) scale reduces the risk of central tendency, where responses may cluster in the middle (Acosta et al., 2020; Kusmaryono et al., 2022). Additionally, the researchers aimed to direct respondents towards a definitive choice, which necessitated using Likert scale with an even-numbered options (Kusmaryono et al., 2022). Overall, the four-point Likert scale was chosen for its ability to encourage decisive responses, improve response rates, and simplify data collection and analysis (Acosta et al., 2020; Alan & Kabasakal, 2020).

The questionnaire consisted several subscales (cf. Table 2) which intended to measure student-teachers' perceptions about the factors contributing to their ICT pedagogical development (Subscales 1-8). Furthermore, subscale nine (9) measured student-teachers' perceived competence in utilising technology in pedagogical practices. Additionally, demographic information, such as age, gender, and educational background, were collected. As indicated in Table 2, an assessment of the questionnaire's internal consistency reliability was conducted using Cronbach's alpha coefficient reliability. The item-total correlation was computed for each item within the subscales of the questionnaires. A coefficient value of α.70 was considered for adequate reliability (Pallant, 2020).

Table 2: Internal Consistency Reliability of Questionnaire Subscale

Questionnaire Subscale		items	α
1.	Prior knowledge and experiences	7	.829
2.	Attitudes and expectations	7	.713
3.	Efforts expectancy	6	.704
4.	Pedagogical beliefs	9	.858
5.	Social influence	5	.693
6.	Operational usefulness of ICT	6	.758
7.	Confidence in ICT uses	6	.745
8.	Facilitative conditions	7	.835
9.	Perceived pedagogical ICT competencies	12	.860
Total			**.856**

Source: Field Data.
Note: α=Cronbach's alpha of internal consistency reliability and total (α=.856) represents the minimum cut-off point.

During data collection researchers met with prospective participants at designated venues and times, providing a brief introduction to the study's objectives before distributing the questionnaires. Of the 200 questionnaires distributed, 187 were returned.

Raw data were converted for analysis by assigning numerical values using the Statistical Package for Social Science (SPSS) version 24. SPSS was used to input, process, and analyse the quantitative data from the questionnaire responses. Two main statistical techniques of data analysis, descriptive and inferential were performed. Descriptive statistical analyses were mostly used to describe student-teachers' perceived ICT competences in utilising technology in content delivery and instructional strategies. The total mean scale was used to interpret how the four-point Likert scale explained the statistical results. Correlation and regression analyses were conducted to explore the relationships between factors contributing to the development of ICT pedagogical competencies. Additionally, comparative analyses were performed to identify differences in perceptions and experiences among student-teachers from different study sites.

Findings

This study sought to investigate the factors influencing student-teachers' development and use of pedagogical ICT competences in teaching and learning process. This section presents the findings with much reflection on the objectives of the study.

Factors influencing the development of pedagogical ICT competences

Research question one aimed to explore the factors influencing the development of ICT-pedagogical competencies among student-teachers. Firstly, the research objective aimed to determine the extent to which the combined eight independent variables influence and correlate with the level of development of pedagogical ICT competences. To assess the model's overall fit, the proportion of variability in the dependent variable as explained by the independent variables (R-squared) and the overall significance of the model were calculated. A summary of the overall model fit is presented in Table 3.

Table 3: Multiple Regression Model Significance (ANOVA)

Model		Sum of Squares	df	Mean Square	F	Sig.	R	R^2
1	Regression	387.25	8	48.406	2.334	.021b		
	Residual	3691	178	20.736			0.308	0.095
	Total	4078.3	186					

Source: Field Data.

This regression means that the square (48.406) is greater than the mean square for the residual (20.736), which provides statistical evidence to claim that the regression equation is a good fit for the data (Pallant, 2020). The F-statistic (2.334) and the associated low p-value (.021) indicate that the regression equation was statistically significant at .05. The findings indicated that the model explained a certain amount of variability in the dependent variable and that at least one of the independent variables had significant effects on it. Therefore, the combined independent variables statistically predicted the development of pedagogical ICT competences among undergraduate student-teachers.

Furthermore, the findings from multiple regression analysis revealed the magnitude of the influence of each of the eight independent variables (predictors) and its significant influence on the development of pedagogical ICT competences. Table 4 gives a summary of the findings.

Table 4: A Summary of the Multiple Regression Model Coefficients

		t	Sig.	Correlations	
Factors	**Beta**			**Part**	**Part^2**
Pedagogical beliefs	-0.23	-2.712	0.007*	-0.193	0.0372
Facilitative conditions	0.201	2.451	0.015*	0.175	0.0306
Confidence in ICT uses	-0.129	-1.413	0.159	-0.101	0.0102
Attitudes and expectations	0.097	0.981	0.328	0.07	0.0049
Prior knowledge	-0.078	-0.788	0.432	-0.056	0.0031
Efforts expectancy	-0.069	-0.743	0.459	-0.053	0.0028
Social influence	0.02	0.199	0.843	0.014	0.0002
Operational usefulness	0.011	0.158	0.874	0.011	0.0001

Source: Field Data
Dependent variable: Development of pedagogical ICT competences
*=the variable significantly predicting the dependent variable

The findings indicate that facilitative conditions had statistically significant positive effects (beta=0.201, t=2.451, sig=0.015). The other three factors revealed a positive but statistically insignificant relationship: "attitudes and expectations" (beta=0.097, t=0.981, sig.=0.328), "operational usefulness' (beta=0.11, t0.158, sig.=0.874), and "social influence" (beta=,0.02, t0.199, sig.=0.843). Pedagogical beliefs related to teaching factors (beta= -0.23, t=-2.712, sig.=0.007) revealed a significant negative relationship. On the other hand, these three factors revealed statistically insignificant negative relationships. These factors are "effort expectancy" (beta-0.069, sig- 0.459), "ICT-self efficacy related to teaching (beta=-0.129, sig=-1.413, sig.=0.159)", and "prior knowledge" (beta=-0.078, t=-0.788, sig.=0.432). Based on these findings, it can be concluded that variables related to facilitative conditions, such as access to technological infrastructure, are the most influential factors in the development of ICT pedagogical competences of undergraduate student-teachers. Other influencing variables were those related to attitudes, expectations, operational usefulness, and social influences.

Perceived pedagogical ICT competences related to content delivery and instructional strategies

The significance of assessing perceived pedagogical use of ICT competences among student-teachers lies in its potential to get insights about their readiness to spearhead pedagogical use of ICT in their future pedagogical practices**.** Research question two specifically focused on two main domains of teachers' knowledge required for effective ICT integration in teaching and learning. The first is technological content knowledge (TCK), knowledge, and skills related to understanding the pedagogical potential of ICT in content delivery (i.e. how to use technology to present

content). The second domain is technological pedagogical knowledge (TPK), which refers to the competences related to the pedagogical use of technological tools and resources. TPK involves knowledge and skills regarding the pedagogical potential of ICT in fostering instructional strategies. Therefore, in this study, content delivery and instructional strategies were the specific pedagogical aspects assumed to be influenced by the perceived pedagogical use of ICT competences. The findings are based on these two main aspects of knowledge and skills associated with pedagogical use of ICT competences, as shown in Table 5.

Table 5: Perceived Pedagogical use of ICT Competences of Student-Teachers (n=187)

Perceived Pedagogical use of ICT Competences	**Not skilled at all N (%)**	**Not very skilled N(%)**	**Fairly skilled N(%)**	**Very skilled N(%)**	**Mean ±SD**
Pedagogical use of ICT competences in content delivery					
Ability to select the ICT that is specific to the subject area	0(0.00)	5(2.67)	72(38.50)	110(58.82)	3.56±0.55
Ability to use digital content	1(0.53)	4(2.14)	67(35.83)	115(61.50)	3.58±0.57
Ability to use multimedia resources to represent the content	4(2.14)	9(4.81)	43(22.99)	131(70.05)	3.63±0.66
I can connect technology use to the key concepts, skills and process of the specific subject area	0(0.00)	4(2.14)	48(25.67)	135(72.19)	3.70±0.50
I can use technologies to solve a subject problem (e.g. Mathematics problems)	3(1.60)	9(4.81)	56(29.95)	119(63.64)	3.56±0.66
Choose technology tool that facilitates student engagement	0(0.00)	3(1.60)	57(30.48)	127(67.91)	3.66±0.51
Overall	8(4.27)	0(0.00)	48(25.67)	139(74.33)	3.74±0.44
Pedagogical use of ICT competences in instructional strategies					
Use of multimedia	4(2.14)	9(4.81)	45(24.06)	129(68.98)	3.60±0.68
Lecture capturing	6(3.21)	16(8.56)	66(35.29)	99(52.94)	3.38±0.78
Use of interactive simulations	6(3.21)	11(5.88)	70(37.43)	100(53.48)	3.41±0.75
Use of education games	10(5.35)	27(14.44)	103(55.08)	47(25.13)	3.00±0.78
Use of web-based learning	10(5.35)	27(14.44)	76(40.64)	84(44.92)	3.25±0.83
Searching and using e-books	7(3.74)	14(7.49)	53(28.34)	113(60.43)	3.45±0.79
Overall	5(2.67)	8(4.28)	64(34.22)	110(58.82)	3.49±0.71

Source: Field data

The results show that about 74% of the respondents perceived themselves as very skilled and 25.67% said they were fairly skilled in ICT pedagogical competencies related to incorporating technological tools and resources in content delivery. On the other hand, 58.82% of the respondents reported they were very skilled and 34.22% said they

were fairly skilled in ICT pedagogical competencies related to integrating technologies in instructional strategies. Therefore, the findings revealed relatively moderate-to-high levels of perceived ICT pedagogical competencies. However, there were variations within and across the constructs assessed. For example, in using digital simulations as a pedagogical strategy, the quantitative results suggested that student-teachers perceived themselves with relatively high perceived knowledge and skills (mean =3.56, SD= 0.55), whereas in student-teachers knowledge and skills related to searching and using e-books or textbooks, the findings revealed moderate knowledge and skills (mean =3.45).

A comparison of perceived pedagogical ICT competences training experiences

To determine if significant differences existed between the study groups, particularly among the three study sites, statistical analyses were conducted on the data collected. The results are shown in Table 6 (a & b).

Table 6(a): Total ICT Pedagogical Competencies Training Experiences

Categories	N	Mean	SD	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
University A	79	27.09	3.57	0.40	26.30	27.89	16	32
University B	61	26.82	2.64	0.34	26.10	27.50	21	32
University C	47	26.77	3.81	0.56	25.60	27.88	13	32
Total	187	26.92	3.34	0.24	26.40	27.40	13	32

Source: Field Data

N= Number of the participants, standard deviation

Table 6(b): Multiple Comparisons of Total ICT Skills Training Experiences

Dependent Variable: Overall perceived ICT pedagogical competencies **Tukey HSD**						
(I) Degree	**(J) Degree**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95%Confidence Interval**	
					Lower Bound	Upper Bound
University A	University B	0.27	0.57	0.89	-1.08	1.62
	University C	0.32	0.62	0.86	-1.14	1.79
University B	University A	-0.27	0.57	0.89	-1.62	1.08
	University C	0.05	0.65	1.00	-1.49	1.59
University C	University A	-0.32	0.62	0.86	-1.79	1.14
	University B	-0.05	0.65	1.00	-1.59	1.49

Source: Field Data

Based on Tables 6(a and b), the analysis shows that there were no statistically significant differences among the study groups from the three universities. Therefore, it is reasonable to conclude that respondents in the present study did not differ significantly in their level of perceived ICT pedagogical competence based on their respective universities. The computation of effective size indicates that the magnitudes of the differences were also very small, suggesting that the group features of the respondents were less likely to account for their perceived level of ICT pedagogical competence development.

Discussion

The rationale of this study focused on understanding how student-teachers perceive factors influencing the development and pedagogical use of ICT competences. The discussion of the research findings, therefore, revolves around these two key aspects.

Factors influencing the development of pedagogical ICT competences

Factors influencing the development of pedagogical ICT competences among student-teachers were examined through the lens of the Theory of Planned Behaviour (TPB). TPB, a psychological theory, explains how individuals' attitudes, subjective norms, and perceived behavioural control and affect their intentions and actions (Ajzen, 1991; Şimşek & Ateş, 2022). Using TPB's core variables, the first question of this study explored eight factors influencing the development of pedagogical ICT competences among student teachers.

The findings indicated that factors related to the perceived behavioural control variable, particularly facilitative conditions, are the most significant predictors of the development of pedagogical ICT competences. This is consistent with previous

research, which suggests that facilitating conditions, such as easy access to technological resources, predict teachers' intentions to use ICT in classrooms (Cabellos et al., 2024; Legros & Cislaghi, 2019; Veiga & Andrade, 2021). For example, Cabellos et al. (2024) highlighted the importance of institutions in facilitating conditions in teachers' pedagogical practices empowered by ICT. Student-teachers who recognize the availability of essential ICT tools, resources, and institutional support are more likely to believe that they can effectively develop their pedagogical ICT competences. Inadequate facilitative conditions may result in less ICT uptake, even for student teachers who have positive attitudes towards the application of ICT competences in teaching and learning.

Also, literature identifies several contextual factors that can either limit or support the development of pedagogical ICT competences in both in-service and pre-service teachers. Key factors include institutional infrastructure, such as the provision of ICT resources, technical and educational support, digitalisation policies, administrative commitment, and organisational development (Jin, 2019; Sailer et al., 2021; Vo, 2019). Additionally, role modelling and peer support networks, which encourage collaborative learning and sharing of ICT integration practices, are also crucial (Qureshi et al., 2023). These institutional, organisational, and administrative factors create a supportive environment that fosters the development of teachers' pedagogical ICT competences and promotes continuous learning and effective ICT integration.

In developing countries like Tanzania, supportive services such as ICT infrastructure, including reliable internet access, are often limited or entirely unavailable (Mtebe et al., 2021; Zarei & Mohammadi, 2022). The lack of established or adapted technological infrastructures for educational transformation in many developing nations is a major reason why the present study found no significant differences between respondents' perceived ICT pedagogical competence levels based on their respective universities. This limited technological infrastructure poses a significant challenge for both students and teachers in developing pedagogical uses of ICT competencies (Zarei & Mohammadi, 2022). Similarly, lack of facilitative conditions can lead to frustration among student-teachers, resulting in low adoption of ICT for pedagogical purposes. Furthermore, without sufficient technological and academic support, the development of these competences can be inconsistent and less effective, reducing the potential benefits of integrating ICT into teaching (Cabellos et al., 2024; Sailer et al., 2021).

Enhancing contextual factors, such as facilitating conditions and social support, can create a supportive environment for student-teachers to develop their ICT pedagogical competencies. This includes improved access to ICT infrastructure, technical support, and opportunities for collaboration (Vo, 2019). Establishing institutional policies and a supportive framework is essential. Personal factors, including perceived usefulness, attitudes, and expectations, are also critical. Teacher education institutions can also support this by highlighting the relevance and benefits

of ICT, involving role models, and building confidence among student-teachers (Cabellos et al., 2024; Tondeur et al., 2019). The current study examines both personal and contextual factors that influence the development of ICT competences among student-teachers. Consequently, the study provides a deeper understanding of how both individual characteristics and external contexts shape technology integration in educational settings. Nevertheless, both types of factors should be considered in fostering these competences (Howard et al., 2021).

Perceived pedagogical use of ICT competences

In this study, pedagogical use of ICT competences among student-teachers was examined as TPACK competences, particularly in terms of two variables of TCK and TPK. In the whole, TPACK variables inform the integrated functional use of ICT competences for educational purposes, but it is within TCK and TPK where ICT assumes a key role (Miguel-Revilla et al., 2020). While TCK addresses applications of ICT in content delivery and the ways in which technology can be used to present content, TPK focuses on the way the ICT competences can be applied for instructional strategies (Mishra & Koehler 2006; Miguel-Revilla et al., 2020).

Student-teachers perceived themselves to be more competent in applying ICT competences for content delivery compared to their moderate perceptions of using ICT in instructional strategies. These findings highlight disparities in how student-teachers view their knowledge and skills in utilising ICT tools for content delivery versus instructional strategies. Similar results have been observed in previous studies, which also found that student-teachers do not consider themselves sufficiently competent in applying ICT competences to enhance instructional strategies (Miguel-Revilla et al., 2020).

The perceived disparities of pedagogical use of ICT competences between content delivery and instructional strategies can be attributed to different factors. While internal factors such as attitudes motivate the use of ICT as a pedagogical tool, facilitative conditions provide the necessary support for acting on these motivations. Therefore, fostering positive attitudes towards ICT in teaching and demonstrating its genuine usefulness can also significantly enhance student-teachers' pedagogical use of ICT competencies (Tondeur et al., 2019; van Twillert et al., 2020). According to similar studies on student-teachers' development of TPACK, the factors that lead to differences in use of ICT competences include influence of lecturers as role models and cultural and contextual factors such as the introduction of digital technologies (Jin, 2019; Lucas et al., 2021). Furthemore, Lucas et al. (2021) found that contextual factors, including access to technological tools, can determine teachers' beliefs, consequently affecting their perceived technological pedagogical content knowledge and use. These findings underscore the need for a nuanced approach to developing pedagogical ICT competences that acknowledges and addresses the distinct impacts of TPACK variables, including TCK and TPK. To effectively enhance student-teachers' ICT competences, the approach should be comprehensive, context-sensitive, and supported by targeted

professional development (Tondeur et al., 2019). This will ensure a balanced growth across all TPACK domains.

Conclusion and Implication

This study highlights the critical factors influencing the development and application of pedagogical ICT competences among student-teachers in Tanzania. The findings reveal a significant positive correlation between facilitative condition factors and the development of these competences. While attitudes, operational usefulness, and social influences also showed positive correlations, they were statistically insignificant. Notably, a substantial majority of respondents reported high self-perceived skills in content delivery and incorporating ICT into instructional strategies. These insights suggest that while student-teachers feel confident in their ICT competences, there are underlying factors that could further enhance their development and integration of technology in education.

The findings of this study have significant implications for educational policies, practices, and research in Tanzania. By understanding the strengths and weaknesses of the current pedagogical technology training programmes, policymakers can design targeted interventions to enhance teacher preparedness and promote technological integration in schools (Elliot et al., 2020). Additionally, colleges and teacher-training institutions can use these findings to inform curriculum development, instructional design and professional development initiatives aimed at equipping student-teachers with the right skills and competences needed to thrive in the digital age (Manurung et al., 2022).

Mastering the digital frontier in education requires concerted efforts to strengthen pedagogical technology training programmes (Ndibalema, 2019), and to support the effective integration of technology in teaching practices. By addressing the challenges, maximising the opportunities, and leveraging the best practices, Tanzania can cultivate a cadre of digitally fluent teachers capable of harnessing the transformative potential of technology to enhance student learning outcomes and drive sustainable development in the 21st Century.

This study underscores the pivotal role of pedagogical technology training in shaping the future of education in Tanzania. By equipping student-teachers with competences to effectively integrate technology into their pedagogical practices (Majani, 2023), Tanzania can foster a culture of innovation, collaboration, and inclusive education (MoEST, 2024). Moreover, by nurturing a cadre of digitally fluent teachers, Tanzania can harness the transformative potential of technology to address pressing educational challenges and catalyse sustainable development. Sustained efforts from policymakers, teachers, and other stakeholders are essential in realisation of the vision of a technologically empowered educational system that prepares students for success in the 21st century and beyond.

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