ISSN 2962-5548
https://doi.org/10.56773/ejer.v3i2.64
Eureka: Journal of Educational Research, 3(2), 199-210

An assessment of in-service teachers' confidence and challenges of integrating technology in Tanzanian secondary schools

Paul Loisulie[1]*, Tabu S. Kondo[2]
[1]Department of Educational Management and Policy Studies, University of Dodoma, Tanzania
[2]Department of Computer Science and Engineering, University of Dodoma, Tanzania
*loisulie.paul@udom.ac.tz

Received: December 14, 2024
Revised: April 16, 2025
Accepted: May 19, 2025

Abstract

The integration of technology in education has become a global priority, with the potential to enhance teaching and learning outcomes. In Tanzania, efforts have been made to incorporate digital tools into secondary education to enhance instructional effectiveness. However, the successful adoption of technology largely depends on teachers' confidence and their ability to overcome various challenges. This study assesses Tanzanian secondary school teachers' confidence in using technology and the challenges they face in its integration. Using an online survey design, data were collected from teachers across different regions. Two hundred and three (N=203) in-service teachers responded to the online survey in which 80% are male. The findings indicate that prior to the intervention, 49.3% of respondents rated their ICT skills as "Average," a figure that dramatically decreased to 4% after the intervention. The findings also indicate a strong likelihood that teachers are prepared to apply Technological, Pedagogical and Content Knowledge (TPACK) principles in their teaching practices, with mean scores across various TPACK areas exceeding 4.0. Despite these positive outcomes regarding confidence to implement TPACK principles; inadequate technology infrastructure, limited technological knowledge, resistance to adopting new technologies, difficulties in aligning technological tools with their content knowledge and pedagogical strategies, and language barriers are among the challenges of applying TPACK in the classroom. By fostering an environment that supports continuous learning and adaptation among educators, Tanzania can better equip its teachers to navigate the challenges associated with effectively implementing TPACK in their classrooms.

Keywords

Confidence, in-service teachers, pedagogical strategies, self-efficacy, technology integration.

INTRODUCTION

Tanzania, like many developing countries, faces significant challenges in integrating technology into its education system. Despite global advancements in digital learning, many in-service teachers in Tanzanian secondary schools who play a crucial role in implementing technology-driven teaching strategies, often lack the necessary confidence and skills to integrate digital tools effectively. This situation hinders the effective use of technology in classrooms, ultimately affecting the quality of education.

The Tanzanian government has made efforts to promote educational technology through initiatives such as the Information and Communication Technology (ICT) Policy 2024 [1] and the Education Policy and Training 2014 version 2023 [2]. However, the success of these initiatives largely depends on teachers' ability

and willingness to embrace technology in their instructional practices. Understanding in-service teachers' confidence levels and the challenges they face is essential for designing effective interventions to bridge the digital divide in education.

Globally, there has been a lot of conversation about technology integration in the classroom in recent years. At the same time, many studies have confirmed the educational advantages of technology tools to students when it comes to enhancing their abilities [3], strengthening their skills and overcoming learning challenges [4], problem solving [5], and engaged participation in their learning [6]. Furthermore, they are portrayed as creative tools to educators [4], capable of inspiring students [6], and presenting challenges to educators [7], [8], regarding the integration of resources like social media, virtual classrooms, and other tools that help in teaching and learning [9]. Therefore, it is necessary to ensure that teachers possess the necessary confidence to effectively integrate technology into their teaching practices [10]–[12]. TPACK is a framework proposed by Mishra and Koehler [13] that articulates how the other forms of knowledge previously discussed can be viewed in terms of a technological perspective. It describes knowledge in the interaction of technological knowledge with prior established forms of pedagogical and content knowledge. The integration later led to the formation of the two other forms of knowledge: Technological and Content Knowledge (TCK) and technological and pedagogical content knowledge for the integration of pre-existing conceptions in the support of practice to teaching with ICT for knowledge advancement. Technological pedagogical knowledge is knowledge concerning different technologies used in the teaching and learning process [14].

As noted by Bwalya and Rutegwa [10], and Andoh [15], Ghana and Zambia recognize the application of technology in education. Therefore, each has initiated efforts to enable its practice in their classrooms. Ghana has directed its focus on assessing the technological pedagogical content knowledge of teachers in senior high school business education contexts [15]. In a similar perspective on the same point noted in Zambia, efforts have been made to explore self-efficacy of pre-service science and mathematics teachers in the technological pedagogical content knowledge by comparing the practices of two universities [10]. Low levels of access to technology infrastructure, inadequate teacher training, and availability of digital resources are among the challenges faced by these countries [16], [17]. These are the challenges to equipping teachers with the required expertise and confidence for technology integration. Earlier research has discussed how and why technology could be used in the classrooms of Tanzania [16], [17]. These researches also showed that teachers should have full insight about their levels of confidence, and the conditions under which they're able to successfully use the TPACK model. Therefore, we need to know the level of confidence of using the TPACK model from the in-service teachers in Tanzanian secondary schools to provide them their needs and concerns specifically in this area. Once we know what's affecting teachers' confidence (for example, technological literacy and pedagogical ability), we can focus interventions and professional learning programs to boost confidence in technology use [12].

The theoretical framework of the study, centered around the TPACK model, is integral to understanding how in-service secondary school teachers in Tanzania can effectively integrate technology into their teaching practices [13]. TPACK emphasizes the necessity of a harmonious blend of technological knowledge, pedagogical knowledge and content knowledge for effective teaching [12]. This framework guides the assessment of teachers' confidence in applying TPACK principles, as it provides a structured approach to evaluate their preparedness to utilize technology in enhancing learning outcomes. In this context, the study aims to assess how in-service teachers perceive their confidence in applying these interconnected domains to enhance their teaching practices and improve student learning outcomes after undergoing training. The evaluation focuses on various skill areas related to ICT competencies, which are foundational for applying TPACK effectively. Thus, the TPACK framework not only serves as a theoretical foundation for this study but also informs practical implications for professional development programs aimed at enhancing teachers' confidence and competence in integrating technology into their pedagogy.

However hard the government of Tanzania (specifically the Ministry of Education, Science and Technology (MoEST)) might have worked to set up the educational systems and deliver digital

resources to increase the quality of education [16], [18]–[20], their success depends on the ability of teachers to use the available resources. It is true that the integration process requires not only access to technology but also adequate training and support for teachers to develop their TPACK. A study by Kafyulilo et al. [21] for example found that after teachers' participation in TPACK training seminars for science subjects, classroom practices shifted from teacher centered to student centered and that students were more interested in the lesson that integrated technology. In addition to that, another study by Athuman [22] shows that, Biology prospective teachers perceive themselves as not able to integrate technology in classroom practices despite the fact that they believe to have necessary knowledge about TPACK domains. Moreover, Juma and Mwila [23] found that many teachers recognize the value of ICT in enhancing English instruction, but gaps in technological knowledge and access to resources limit its implementation. Therefore, without the necessary skills and confidence, the potential benefits of educational technology may not be fully realized in Tanzanian classrooms. Consequently, addressing the professional development needs of teachers and providing ongoing support is crucial to ensure the successful integration of technology and the improvement of educational outcomes in Tanzania.

This study aimed at assessing the level of confidence of in-service teachers in applying the TPACK model in the teaching and learning process in Tanzanian secondary schools among the SEQUIP (Secondary Education Quality Improvement Project) training program participants. The study sought to answer the following research questions: (RQ1) What is the level of confidence among in-service teachers in Tanzanian secondary schools to apply the Technological Pedagogical Content Knowledge (TPACK) model in their teaching and learning practices?; (RQ2) What are the challenges that in-service teachers in Tanzanian secondary schools are likely to face in applying the TPACK framework in the teaching and learning process?

RESEARCH METHOD

This study adopted the internet approach popularly known as online survey design. Self-audit survey approach was applied to guide workshop participants to assess their knowledge competency on specific technology categories and those of TPACK. The improvements of ICT have impacted the way things are implemented in all spheres of life including research. This approach (online survey) has not changed the meaning and philosophy of the conventional approaches but the modality of doing it. Currently, instead of using hard copies and other traditional ways, the whole exercise now is done online. Although different studies have raised some methodological issues of contentious for those who opt to use online surveys such as sampling issues, response rate, item nonresponse, data quality and ethical issues, the advantages are tremendously compelling to the extent that its role cannot be ignored in research [24]–[27]. The online survey design is a two-fold venture in a sense that it collects both qualitative and quantitative data using the same instrument with different sections (parts). Both qualitative and quantitative data were collected from the respondents.

Population of the study

The targeted and accessed population of this study involved secondary school teachers responsible for ICT who participated in the one-week in-service training seminar under the facilitation of Secondary Education Quality Improvement Project (SEQUIP). The training aimed at improving and strengthening application of ICT in teaching and learning in schools by building capacity to teachers. This group was purposefully selected as they were privileged to attend the training session on how to improve the use of ICT in teaching and learning. It was easy to collect data from them about their confidence level before and after the training as well as how well they are prepared to apply it in the process of teaching and learning. Since the in-service teachers training workshop had different batches countrywide, the study used the first batch of participants who attended the training in May 2024 at Monduli Teachers College, Arusha Region, Tanzania.

Sampling techniques and sample size

Unlike traditional approaches, Medlin et al. [28] have established three types of samples for online surveys. The samples are such as recruited, unrestricted and screened samples. According to them, the recruited sample involves consultations, selecting and control of access of

the respondents. Unrestricted sample involves unrestricted access and widely sharing of the questionnaire to everyone online or to the targeted population. But a screened sample entails filtering out the data from the only required respondents. Based on this brief explanation, this study employed a recruiting sampling technique in which the first batch of the SEQUIP workshop participants were involved. The said batch consisted of four hundred and thirty-five (N=435) participants. The researchers consulted all the participants in the hall and requested them to participate in filling the online survey. The response rate shows that two hundred and three (N=203) respondents participated in filling the questionnaire. This number exceeds the normal recommended sample size threshold by statistics by far.

Data collection methods and tools

According to Nayak et al. [25], there are three primary electronic data collection methods which are computer-administered surveys, electronic mail surveys and web surveys. For convenience purposes, this study deliberately used the web surveys data collection method whereby the Google form was created. The Google survey questionnaire tool was distributed to the formulated whatsapp group of the respective batch of the workshop attendants at the end of the workshop. Specifically, a self-audit survey questionnaire was designed to allow workshop attendees evaluate themselves on how they view their confidence before and after training. It was a mandatory requirement that each batch of participants were instructed to formulate and join the group to simplify sharing of information among them during training. Prior to communicating the questionnaire, the researchers informed all the respondents about the intention of the data required.

In order to ensure attainment of maximum response rate, participants were reminded frequently and the link containing the Google form was pinned in the whatsApp group. For item nonresponse, it was necessary to make some important questions compulsory in order to ensure that they are all responded to. Only those items with multiple choice in nature were made compulsory to give enough freedom of choice to respondents. The questionnaire was developed in a user-friendly design to ensure all necessary questions were answered appropriately and achieve data quality. Data management was not a challenge since the questionnaire was filled online and the responses were automatically retrieved from Google forms.

Survey duration

The online survey was open for a period of two weeks after the training to ensure maximum participation. Reminder messages on the whatsapp group were sent bi-weekly to encourage completion. Participants were expected to take approximately 20-30 minutes to complete the survey.

TPACK training form

The study included training modules designed to enhance teachers' understanding and application of technology in the classroom. These modules include: Computer Basics, Word processor, Spreadsheet, Presentation, Network and internet, Multimedia and e-learning, Learning management systems, and Basic computer maintenance. The training was delivered through lecture and lab sessions. Furthermore, hands-on assignments were also used in which participants were given practical assignments to apply TPACK principles in their teaching and reflect on their experiences.

Ethical issues

Ethical considerations were adhered to for online surveys in different ways. Respondent's informed consent was sought in two ways; one is through face-to-face consultations and two is through short text introduction and request to participate in filling the survey questionnaire before commencement of the exercise. It means the respondents participated in filling the questionnaire when they consented. Force was not applicable. Anonymity was strictly observed by creating a Google form in which the responses from the participants cannot be linked by anyhow with their identity. More importantly, the respondent was free to drop from participating in the process of filling the questionnaire any time by not submitting the responses before or even at the final stage before submission. The responses collected were kept confidential and used only for research purposes so that they cannot disclose the identity of the respondents.

Data analysis procedures

Data analysis was done through descriptive statistics and content analysis. Descriptive statistics were used to calculate frequencies,

percentages and measures of central tendencies in relation to assessment of the confidence of teachers to apply TPACK in teaching and learning processes. Content analysis was used to analyze data related to challenges which are likely to be encountered by teachers in implementing TPACK in the teaching and learning process. Precisely, conceptual content analysis enabled the researchers to derive themes from the views of the respondents [29], [30].

RESEARCH RESULTS

This study sought to assess the level of confidence and challenges of in-service teachers in Tanzanian secondary schools in applying the TPACK model during the teaching and learning process. This section presents the analysis of the results of the data. It begins by presenting the demographic description of the respondents followed by the level of confidence and challenges of in-service teachers in integrating technology in Tanzanian secondary schools.

Demographic description of the respondents

The description of the profile of the respondents is presented in Table 1, based on the gender, education level, age, experience and subjects.

Table 1. Demographic description

Variable	*f*	%	Variable	*f*	%
Gender			Year of experience		
Male	184	90.60	One to three	48	23.60
Female	19	9.40	Four to six	34	16.70
Educational level			Seven to nine	42	20.70
Diploma	50	24.60	Ten and above	79	38.90
Postgraduate Diploma	1	0.50	Subjects		
Degree	145	71.50	Science	65	32
Masters	7	3.40	Mathematics	44	21.7
Age			Arts and Social sciences	55	27.1
20-30	34	16.70	ICT/Computer science	52	25.6
31-40	150	73.90	Business studies	3	1.5
41-50	17	8.40	Language	24	11.8
51 and above	2	1			

From Table 1, it can be observed that the number of male respondents exceeded that of females by too far indicating that teachers responsible for ICT in secondary schools is male dominated. The difference is above eighty percent (80%). Education wise, degree holders outnumbered other levels of education followed by diploma. This is not a terrifying story because secondary schools should be staffed largely by degree holders as diploma level is almost fading out. The master level of education, though important for career development, is not a mandatory requirement. For age-wise, the majority of respondents come from the age group between 30–40 followed by that of 20–30. This is a signal that the school's manpower is still energetic and ready to learn new experiences to improve their knowledge and skills on teaching and learning processes. In terms of years of experience, it is noted that there is not much difference. Although those with experiences of ten years and above dominated, other groups are fairly distributed. For subjects, it is categorically evident that Business studies teachers are extremely poorly represented in the training. Unfortunately, ICT/computer science teachers who were the real target of this in-service training seminar are not represented properly. The implication of this revelation is that there is high demand for ICT/computer science teachers as well as those from Business studies related subjects. It is therefore a workup call to the government, universities and teachers' colleges to take up initiatives to address this acute shortage.

Evaluation on the trainees' ICT knowledge and skills levels before and after training

The respondents were asked to evaluate themselves on their ICT knowledge and skills levels using a five-point Likert scale, ranging from "Poor" to "Excellent." This self-assessment

was conducted both before and after the training program.

The results in Table 2 reveal a significant transformation in the self-reported ICT proficiency of the participating teachers. Prior to the training intervention, a majority (46.3%) of the trainees categorized their ICT skills as "Average," indicating a general sense of moderate competence. However, post-training, a dramatic shift occurred. Only 3.9% of the teachers continued to perceive their ICT knowledge and skills as "Average" or "Poor," signifying a substantial decrease in self-reported limitations. Conversely, the proportion of teachers who reported possessing "Good," "Very Good," or "Excellent" ICT capabilities surged from 46.3% pre-training to 96% post-training. This dramatic increase suggests a substantial enhancement in the teachers' confidence and perceived expertise within the ICT domain.

Table 2. Self-reported ICT knowledge and skills levels before and after training

Duration	Scale	*f*	%
ICT knowledge and skills levels before training	Poor	9	4.4
	Average	94	46.3
	Good	51	25.1
	Very good	27	13.3
	Excellent	22	10.8
	Total	203	100
ICT knowledge and skills levels after training	Average	8	3.9
	Good	83	40.9
	Very good	67	33
	Excellent	45	22.2
	Total	203	100

Personal evaluation of the trainees

The respondents were asked to evaluate themselves on ICT skills areas after the training. The intention is to determine how much they are prepared to implement the TPACK framework as well as training other teachers. The skills areas evaluated are the basics for ICT in a sense that no teacher can implement the TPACK framework without these skills. Data were descriptively analyzed to calculate measures of central tendencies (mean and median) as well as measures of variation (standard deviation). The findings are presented in Table 3.

Table 3. Technological skills attained after the training

Skills areas	Mean	Median	StDev
General Computing skills/abilities	3.468	3	0.858
Word processor skills	3.714	4	0.877
Spreadsheet skills	3.532	3	0.951
Presentation skills	3.576	3	0.967
Network and internet skills	3.571	4	0.969
Multimedia and e-learning skills	3.404	3	0.920
Learning Management Skills	3.483	3	0.951
Computer maintenance skills	3.315	3	1.009
TPACK skills	3.453	3	0.971

Note: 1=Poor, 2=Average, 3=Good, 4=Very Good, 5=Excellent, StDev= Standard Deviation.

The results in Table 3 show that the self-evaluations of 203 trainees regarding their ICT skills after training indicate a generally positive perception of their competencies across various skill areas. The mean scores for each category range from 3.315 for Computer Maintenance Skills to 3.714 for Word Processor Skills, suggesting that participants feel most confident in word processing while identifying computer maintenance as an area needing improvement. The median scores consistently align with the mean values reinforcing the reliability of these self-assessments. Furthermore, the standard deviations indicate moderate variation in

responses, particularly in computer maintenance skills, which may reflect differing levels of prior experience among participants. These findings imply that while trainees are well-prepared in many essential ICT areas necessary for implementing the TPACK framework, targeted support may be beneficial in enhancing their proficiency in computer maintenance.

It should be noted that the ICT training not only enhanced teachers' technological skills but also positively influenced their pedagogical and content knowledge. This was achieved through the following ways: (i) Teachers learned how to integrate digital tools into their lesson plans, making lessons more interactive and engaging (ii) ICT training enabled teachers to use multimedia tools, simulations, and online resources to enrich subject matter delivery (iii) Teachers developed strategies to personalize learning using digital tools, catering to different student needs and learning paces (iv) ICT-based assessment tools allowed teachers to implement real-time feedback, formative assessments, and data-driven instruction (v) By incorporating interactive platforms and collaborative tools, teachers fostered a more student-centered learning environment.

Likelihood of applying TPACK in teaching and learning

It was necessary to inquire whether or not the trainees were prepared to apply skills they have learnt to apply TPACK in teaching and learning. Data were analyzed using descriptive statistics to calculate measures of central tendencies (mean and median) as well as measures of variation (Standard deviation) to determine how the trainees are generally prepared to implement the TPACK framework in teaching and learning. The findings are as presented in Table 4.

Table 4. Likelihood of applying the TPACK framework in teaching after training

TPACK framework areas	Mean	Median	StDev
Technological Knowledge			
a. Connecting teaching tools e.g., Projectors, Printers without support	4.019	4.000	.944
b. Using MS Word, MS PowerPoint, and other related teaching software easily	4.103	4.000	.914
c. Updating with the technology trends especially that which involves teaching and learning	3.946	4.000	.945
d. Using smart devices very well to assist me in teaching and learning	4.059	4.000	.973
e. Using a number of technologies needed in teaching and learning	3.995	4.000	.972
Pedagogical Knowledge			
a. Assessing students' performance in my courses using ICT	4.000	4.000	.917
b. Adapting my teaching styles to different learners	4.064	4.000	.879
c. Assessing student learning in multiple ways	4.044	4.000	.924
d. Using a wide range of teaching methods in a lecture room setting	4.030	4.000	.906
e. Organizing and maintaining classroom management	4.089	4.000	.918
f. Using ICT to assist in various ways and strategies of developing my understanding of the courses that I teach	4.084	4.000	.905
g. Using ICT to select effective teaching methods to guide student thinking and learning in my courses	4.054	4.000	.940
Content Knowledge			
a. Using the technologies that allow me to represent concepts that would otherwise be difficult to understand	4.044	4.000	.951
b. Choosing technologies that enhance the teaching methods for a lesson	4.084	4.000	.964
c. Choosing technologies that enhance students' learning for a lesson	4.084	4.000	.953

Note: 1=Very Unlikely, 2=Unlikely, 3=Neutral, 4=Likely, 5=Very Likely, StDev= Standard Deviation.

The results in Table 4 indicate a strong likelihood among the 203 trainees to apply the TPACK framework in their teaching and learning processes following the training. The mean scores for various areas of the TPACK framework range from 3.946 for "Updating with the technology trends" to 4.103 for "Using MS Word, MS PowerPoint, and other related teaching software easily", suggesting that participants feel well-prepared to integrate technology into their teaching practices. Notably, all mean values exceed 4.0, which corresponds to

a "Likely" rating on the scale, indicating a high level of confidence in their ability to utilize technological tools effectively. Furthermore, the relatively low standard deviations across the responses—ranging from 0.914 - 0.973—suggest that there is a consensus among trainees regarding their preparedness to implement TPACK, with minimal variation in their responses. This consistency reinforces the effectiveness of the training program in equipping participants with the necessary skills and knowledge to enhance their teaching methodologies through technology integration. In general, the findings highlight the trainees' readiness to apply TPACK principles, which is crucial in fostering an engaging and effective learning environment.

Possible challenges in applying the TPACK in the teaching and learning

The second intent of the study was to determine the challenges that are likely to impede smooth application of TPACK to in-service teachers for teaching and learning upon their return-to-work station. These challenges were identified through an analysis of the responses collected from an open-ended survey question, which enabled the researchers to deductively categorize the emerging codes into four major thematic areas as summarized in Table 5.

Table 5. Themes and codes derived from the data analysis

Themes	Codes
a. Inadequate technology infrastructure and resources	1. Lack of computers, projectors, internet, electricity 2. Insufficient technology facilities like computer labs
b. Limited technological knowledge and skills among teachers	1. Lack of training and competence in using technology 2. Resistance to adopting new technologies
c. Technical challenges	1. Network/internet connectivity issues 2. Misuse of technology by students
d. Curriculum and pedagogical challenges	1. Difficulties in aligning technology with content and pedagogy (TPACK) 2. Language barriers in using technology

The findings in Table 5 reveal several key challenges that in-service secondary school teachers in Tanzania are likely to encounter when applying the TPACK framework in their teaching and learning processes.

Inadequate technology infrastructure and resources

The first main point that came up is the problem of not having enough technology infrastructure and resources. Teachers noted a big shortage of necessary tech tools like computers, projectors, reliable internet, and steady electricity. This lack of basic tech equipment makes it hard for them to use technology in their teaching methods effectively. Additionally, the results show that there are not enough specialized tech spaces, such as computer labs, which are vital for giving students practical technology experience and learning opportunities. The absence of these critical tech resources is a major obstacle to successfully applying the TPACK framework in Tanzanian secondary schools.

Limited technological knowledge and skills among teachers

The second main point addresses the limited tech knowledge and skills among current teachers. Findings suggest that many teachers do not have the needed training or skills to use technology for teaching. This lack of tech proficiency, along with hesitance to adopt new tools, creates a serious issue for effectively implementing the TPACK framework. Teachers' unwillingness to accept new technology and their limited tech skills can make it difficult for them to blend technology with their teaching methods and subject knowledge, as the TPACK model requires.

Technical challenges

The third main point focuses on technical difficulties, like problems with network and internet access, along with worries about students misusing technology. These technical issues can disrupt the smooth use of technology in teaching and learning activities. Unreliable internet and connectivity issues can disrupt technology

integrated lessons and students misusing technology (using devices for non-educational purposes) can add to the challenges teachers face in applying the TPACK framework.

Curriculum and pedagogical challenges

The fourth theme is curriculum and pedagogical challenges. Teachers reported difficulties in aligning technology with their content knowledge and pedagogical approaches as required by the TPACK framework. The gap between the technological, content and pedagogical domains is a major obstacle to technology integration in teaching and learning. Language barriers were also cited as a concern in using technology enabled instructional materials which can further hinder the application of the TPACK model.

DISCUSSION

This study aimed at exploring the confidence and challenges of in-service teachers in the TPACK model implementation during the teaching and learning process in Tanzanian secondary schools. Results show a pronounced improvement in teachers' ICT knowledge and skills after taking part in a focused TPACK-based training course. Specifically, before the intervention, 49.3% of the participants reported their ICT expertise was 'Average,' but this percentage dropped by a remarkable degree to only 4% following the training. This transformation is a testament to the success of the training and also corresponds to the essence of the TPACK framework where technology, pedagogy, and content together shape future generation teachers [13]. This is particularly true given the broad array of empirical evidence supporting such a claim [16], [17].

ICT skills self-evaluation showed that although teachers were more confident in the use of basic computer applications, such as word processing, expressed deficiencies were related to computer maintenance. Inconsistency therefore implies an urgent call for a complete program by the Ministry of Education, Science, and Technology that prepares professionals not only on theoretical knowledge but also on actual practice. The outcomes agree with Abbott et al. [14] in the view that effective professional development lies in a comprehensive approach to education, whereby teachers acquire the fundamental base knowledge for proper TPACK implementation.

Teachers are likely prepared and have the aptitude to apply the TPACK concept in their pedagogical practices since the mean scores of all different TPACK domains (greater than 4.0) indicate this readiness, which is very important for the increased demands of technology integration in the pedagogical environment. These results also support the outcome of [16], [18]–[20]. Thus, reflecting on TPACK's guiding framework that assists them in maneuvering the challenges accompanying the integration of technology in teaching, as supported by Mishra and Koehler [13].

Although the study resulted in improvements in confidence and perceived readiness to implement TPACK principles, some barriers are likely to prevent it from being applied in practice effectively. The first is the "low technology infrastructure" environment in which there are no computers, there is unreliable internet access, and unstable electricity. These claim that there is not an enabling environment supporting effectual integration of technology into pedagogical practice. To address this challenge, Government and Private Sector Partnerships are recommended where collaborations between the government, NGOs, and private entities can facilitate the provision of digital resources and internet connectivity in schools. Furthermore, schools can adopt cost-effective ICT tools such as mobile learning applications and offline digital content to support teaching and learning.

Equally important, low levels of technological knowledge among the teaching staff and their resistance to using new technologies compound the problem. The findings bring out some systemic problems within the Tanzanian educational setting that, according to other scholars, place a demand on policymakers and institutions of learning to go beyond mere training to make available the requisite materials for pedagogical innovation [25]. To overcome the low levels of technological knowledge, regular workshops and online training sessions can be organized to enhance teachers' ICT skills. In addition to that, teacher education programs should incorporate practical ICT training to ensure new teachers are well-equipped for technology integration. On the other hand, resistance to adopting new technology can be addressed by providing recognition, certifications, or career advancement

opportunities for teachers who actively integrate ICT. Moreover, simplifying ICT integration by providing ready-to-use lesson plans and digital resources can ease teachers' burden and hence encourage its adoption.

Moreover, challenges related to curriculum and pedagogy pose further barriers on the effective implementation of the TPACK framework. It is stated that teachers have problems on how to mesh the use of technology tools within their areas of content knowledge and teachings which are necessary for effective delivery in a technological environment [31]. This challenge can be addressed by providing subject-specific technology training. This will ensure that teachers can effectively integrate ICT into their pedagogical practices. Nevertheless, teachers should be trained using actual classroom scenarios to practice integrating technology effectively.

Language issues also were raised regarding technological instructional materials which were used for teaching. To address the language barriers, educational resources should be available in Kiswahili and other local languages to enhance accessibility. Nevertheless, ICT training content should be designed with easy-to-understand instructions to accommodate teachers with varying levels of language proficiency.

All these problems highlight the challenges of technology adoption in education and imply that for productive outcomes, professional development needs to cover for technical skills, pedagogical practices and curriculum integration. Tanzania can better prepare its teachers to address the intricacies of TPACK implementation by creating conducive environments for TPACK-driven practices and implementation as well as teacher learning in the course of practice.

The effects of these findings are quite important. The reported high increase in levels of ICT competencies by the respondents calls for further TPACK centered training in the professional development courses. Such programs can foster a teaching force that is more conversant with modern technology and this will have a positive bearing on students' learning. Furthermore, it was also established that some specific units of competence should be improved, i.e. computer maintenance, which reiterates the requirement for deeper professional development [12]. In addition, the more general findings are in line with the notion that teacher self-confidence plays an important role in the effective use of technology in education. The more confident the teachers feel with ICT, the more likely they are to try new teaching strategies. This fits in the model of TPACK that explains that technology, pedagogy, and content knowledge have to be interwoven and well-integrated for effective teaching in technology-enhanced settings [14]. The above remarks are also supported by the data revealing improved confidence of teachers as a result of TPACK training.

CONCLUSION

Based on the above findings, we can also conclude that the targeted TPACK-based training can potentially enhance the confidence and competence of in-service secondary school teachers in using ICT in teaching and learning processes in Tanzanian schools. The results show a similar trend of improvement among teachers' ICT competencies in relation to the emphasis of the TPACK framework on technological, pedagogical, and content knowledge integration. On the other hand, the progress made is also punctuated by challenges of poor tech infrastructure, lack of adequate technology use knowledge, and curriculum discrepancies which all impede the successful implementation of TPACK approaches. This calls for a more in-depth analysis of the issues so that there can be provision of an educational setting that utilizes technology in teaching and learning activities. The study recommends that ongoing professional development programs should continue to emphasize TPACK-based training. These relate to not only the theories but also practice. Even if they are integrated into practice, teachers need to be skilled in particular aspects such as how to maintain computers as well as the more advanced uses of ICT.

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