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Exploring the Impact of Teachers' Technology Integration and TPACK Competencies amidst COVID-19: A Mixed-methods Study for Future Educational Preparedness in School

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Author's contribution

This The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

COVID-19 and the subsequent closure of the schools across Bhutan, to check the spread of the virus forced the Ministry of Education and Skills Development to transition to online teaching and learning. Teachers were mandated by emergency policies to teach students online through the use of technology, social media, and other social network platforms. Technology integration is influenced by both first and second-order barriers and the quality of technology integration ranges from low-quality integration to high-quality integration. Using survey data from a sample of 110 teachers and interviews with 26 teachers in five districts of Bhutan, this research attempted to identify and delineate teachers technological pedagogical content knowledge and the draw its relation to the quality of technology integration. Sequential explanatory mixed-methods design, which enables researchers to first collect quantitative data and analyze the data to draw first set of

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findings was used. The findings of the survey were used to guide the interviews conducted during the second phase of the research. Results indicate that teacher are neither proficient in the various dimensions of TPACK nor required too much assistance to navigate the challenges to technology integration. The interview data did not reveal high-quality technology integration in the teaching learning process. Recommendations for policy and practices are provided.

Keywords: TPACK; technology integration; teaching and learning; ICT tools; projectors; smart television sets.

1. INTRODUCTION

The outbreak of COVID-19 and related school lockdowns forced the Ministry of Education around the world to shift to remote, technology-based education [1]. Teachers' technological pedagogical content knowledge (TPACK) was never more important than during school closures due to COVID-19, to ensure that students were actively involved in their learning. According to UNESCO [2], more than 1.5 billion children worldwide were affected, and students could not continue learning remotely in 2020. Furthermore, concerns have been expressed about teachers' technological integration competencies [3]. This research investigated teachers' quality of technology integration and TPACK competencies to make a case for educational system policymakers to be better prepared for such future scenarios.

1.1 Central Research Question

To what extent and in what ways do teacher competencies in TPACK influence the level of technology implementation in classrooms?

1.1.1 Sub-questions

1. To what extent are teachers competent in TPACK to successfully integrate technology in their teaching?
2. What are their lived experiences of the challenges and opportunities for integrating technology in their teaching?
3. Do the lived experiences of technology integration reveal high or low-quality technology integration?

1.2 Research objectives

The overall objective of the research is to provide sufficient evidence for policymakers to make informed decisions about investments in educational technology. In doing so, this research attempted to determine the levels of teacher competencies in TPACK first and delineate the opportunities and challenges of technology integration.

2. LITERATURE REVIEW

One and a half billion children across 165 countries were affected by the closure of schools, which aimed at facilitating social distancing measures to fight the onslaught of COVID-19 [1]. Schools and higher education institutions were forced to adopt and adapt to distance or remote learning [3,4], which relied extensively on information communications technology (ICT). However, this posited challenges for both the learners and the instructors, "forcing all to continuously adjust and adapt to the changing teaching and learning pedagogy" [5]. Critically important in such teaching and learning environment are the teachers' competencies in the use of ICT. Research during and after the COVID-19 period in Australia suggests that students perceived that their lecturers required help and trainings in effectively incorporating technology in virtual classrooms [5,2]. But what exactly is technology integration in educational settings?

2.1 Technology Integration

Teacher technological integration refers to teachers' use of ICT to support teaching and learning [6], and is typically construed in terms of instructional quality. Moersch [7] put forth seven levels of technology implementation or the LoTi framework, consisting of non-use, awareness, exploration, infusion, integration, expansion, and refinement corresponding to increasing quality integration. Low-quality technology integration occurs when teachers use technology to prepare and deliver lessons, collect feedback, and grade students' work. High-quality integration refers to a state where the teacher uses technology to support student-centred, self-directed, and facilitate adaptive learning. Teachers' successful integration of technology is affected by several factors, which are broadly conceptualized as being internal and external to the teacher [8,9]. External factors include technical support, principal support, administrative support, pedagogical support, and the availability of digital learning resources. Internal factors include teacher beliefs about and interest in teaching with technology, as well as teacher anxiety about new educational technology [6].

Research about the influence of internal and external factors on teachers' technology integration has found both positive and negative relationships. Hur et al. [9] conducted a study to investigate the relationship between internal and external factors affecting technology use in the classroom with data collected from 223 teachers. Using structural equation modelling, they determined that teachers' perceived benefits of technology integration were a significant predictor of technology use, while perceived self-efficacy did not predict technology use. However, perceived self-efficacy did have a significant impact on the perceived benefits of technology use. The appropriate budget was also a significant predictor of teachers' technology integration. Inan and Lowther [6] conducted a path model analysis of the data collected using the Teacher Technology Questionnaire from 1382 teachers. Inan and Lowther [6] reported that teachers' higher levels of computer proficiency, higher levels of readiness, positive beliefs, availability of computers, and availability of support positively influenced technology integration. But, during the school closure as a result of the spread of COVID-19, irrespective of the influence of internal and the external factors on technology integration, teachers and lecturers had no choice but to transition to remote teaching.

2.2 Technological Pedagogical Content Knowledge

Technological pedagogical content knowledge (TPACK) is a framework for measuring the knowledge base teachers need to effectively teach with technology [10]. TPACK consists of three core elements, content knowledge, pedagogical knowledge, and technological knowledge, which intersect to form four hybrid components of pedagogical content knowledge, technological pedagogical knowledge, technological content knowledge, and technological pedagogical content knowledge. It is postulated that for a teacher to effectively integrate technology into teaching, they need to be proficient in all three core components of TPACK [11,10]. Research has determined several variations in teachers' competencies in the seven domains of TPACK and has been lso influenced by several demographic characteristics. Bas and Senturk [12] used TPACK to assess in-service teachers' competencies in all seven domains with 200 teachers in Turkey. Teachers reported the highest competencies in content knowledge and the lowest in technological content knowledge, indicating that they were not able to integrate technology successfully to deliver their content knowledge. It was also obtained that male teachers were more proficient in integrating technology compared to female teachers. Similar findings were obtained with a sample of Singaporean teachers by Lin et al. [13]. Similarly, both Bas and Senturk [12] as well as Lin t al. [13] reported that teachers' technology integration in teaching was dependent on teachers' years of experience. The more years spent teaching, the lesser teacher's tendency to integrate technology.

2.3 Significance of the Study

The significance of the study cannot be sufficiently underscored for both policy and practice. During the pandemic, the Ministries of Education and universities had to quickly transition to remote, online teaching and learning without having the time to adequately prepare teachers on integrating technology effectively. Literature suggests that there were numerous knowledge domains which influence the quality of technology integration, and both internal and external factors influence teachers' technology integration [8,9,6,10]. It is also evident that not all teachers are equally competent to integrate technology into teaching [12,13]. Thus, by conducting this research it is anticipated that critical gaps in knowledge, especially in terms of teachers' TPACK and technology integration will be filled, which will allow the policymakers to make informed decisions about technology integration. It is also established that targeted and sustained professional development on technology integration for teachers, facilitates high-quality technology integration in the classroom [14,15]. Therefore, by critically examining the teachers' technology integration knowledge gaps and instructional quality, targeted and sustained partnerships and professional development programs can be developed.

2.4 Motivation for the Research

Technology integration in the teaching-learning process was and continues to be a top priority for the education system, and Bhutan is currently implementing an ICT flagship program worth Nu. 1 billion, which is a significant amount considering the size of Bhutan's economy [16]. Evidence points to the fact that teachers are simply incorporating technology because of policy mandates in the United Kingdom [17], and lack of technical competence among teachers and lecturers is affecting technology integration in the Australian educational milieu [2], which are developed economies compared to Bhutan. The researcher is daunted by the prospect of teachers not being adequately prepared to facilitate maximum student engagement and learning because of the ICT flagship program in Bhutan, after having expended a substantial amount of funds. In addition to the financial risks, education policy documents in Bhutan do not mention anything about pre-service and in-service teachers' TPACK [18].

2.5 Theoretical Framework

This research has used two prominent theoretical frameworks; Technology Acceptance Model [19] and self-efficacy theory [20]. TAM is widely used as a theoretical model to explain an individual's use of technology [21,22]. TAM postulates that the use of technology is determined by the behavioural intentions to use it, which in turn is influenced by the perceived usefulness and the perceived ease of use. Davis [19] defines perceived usefulness as the degree to which a user believes that the use of technology would enhance job performance, and perceived ease of use as the degree to which the user believes that the use of technology will be free of effort. If a user believes that the technology enhances their job performance and if the technology can be used without much struggle, then the user is more likely to accept its use. Self-efficacy refers to technology users' beliefs about their competence to execute the behaviours necessary to produce specific performance [20]. Persons with higher self-efficacy beliefs are more likely to perform and persist in the execution of the behaviours that are necessary to achieve a particular performance [20]. Since there are numerous factors influencing teachers' technology integration and differences in TPACK core components, the use of TAM and self-efficacy theory would enable the researcher to understand the knowledge gaps about technology integration, as well as teachers' self-efficacy beliefs about the core components of TPACK.

3. METHODS

Sequential explanatory mixed methods design [23,24] could be employed to conduct this research. Sequential explanatory mixed-methods design involves a two-phase project in which the researcher collects quantitative data in the first phase, analyses the results, and then uses the results to plan (or build on to) the second, qualitative phase. The quantitative results typically inform the types of participants to be purposefully selected for the qualitative phase and the types of questions that will be asked of the participants. The overall intent of this design is to have the qualitative data help explain in more detail the initial quantitative results. A typical procedure might involve collecting survey data in the first phase, analyzing the data, and then following up with qualitative interviews to help explain the survey responses [24]. The sequential explanatory strategy is chosen because of its advantages. Creswell [23] asserts that the two-phase approach of quantitative research followed by qualitative research makes it easy to carry out, describe and report. It allows the researcher to expand on the quantitative findings. However, surveys are constrained by a lack of rich descriptions of why, and how that phenomenon of interest confounds the problem being investigated. Therefore, following up with qualitative interviews with teachers would enable the researcher to delve into the phenomenon of interest uncovered to a larger depth and detail. Qualitative content analysis technique [25-27] was used to analyse the qualitative data.

3.1 Data

Quantitative data were collected from 110 teachers teaching various subjects and class levels in Mongar, Bumthang, Trongsa, Sarpang and Trashi Yangtse Districts. The survey was administered online using Google Form. 68.2 % of the participants were male and 40.9% of the sample reported that they received some sort of training on technology integration. Eighty-six teachers who responded to the survey indicated that they taught mathematics, eighty-eight participants taught social sciences and science, and 92 teachers reported that they taught language subjects. Twenty-six teachers were interviewed in their natural setting. Semi-structured interviews [28] were conducted, which allowed the researcher to ask probing questions to solicit more information.

4. QUANTITATIVE RESULTS

Technology knowledge (TK) was measured using seven Likert-items, which were scored from strongly disagree (1) to strongly agree (5). Items such as I know how to solve my technical problems were indlcuded to measure TK. The descriptive results for TK is provided in Table 1. The means of the individual statements and the overall mean indicate that the participants were neither proficient users of technology nor completely unaware of how to use technology.

To ensure that the instrument used for quantitative data collection is reliable, Cronbach's alpha [29] was computed for all the seven domains of TPACK, and it was found to be well over the recommended .7 [30].

The descriptive results and Cronbach's alpha values obtained are provided in Table 2. The means of all the sub-scales were obtained to be between 3.09 and 3.99, when scored from 1 to 5. The means indicate that teachers' content knowledge, pedagogical knowledge, pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) were all average, neither being proficient nor struggling to cope.

Table 1. Descriptive results of technology knowledge scale

Alpha = .915	***N***	***Min***	***Max***	***Mean***	***Std. Dev***
I know how to solve my own technical problems.	110	1.00	5.00	3.19	1.00
I can learn technology easily.	110	1.00	5.00	3.30	1.02
I keep up with important new technologies.	110	1.00	5.00	3.56	1.00
I frequently play around with the technology.	110	1.00	5.00	3.55	1.08
I know about a lot of different technologies.	110	1.00	5.00	2.97	0.83
I have the technical skills I need to use technology.	110	1.00	5.00	3.20	0.99
I have had sufficient opportunities to work with different technologies.	110	1.00	5.00	2.92	0.96
				3.24	0.98

Table 2. Descriptive results and Cronbach's alpha values

CK Mathematics (Alpha =	***N***	***Min***	***Max***	***Mean***	***Std. Dev***
I have sufficient knowledge about mathematics.	86	1.00	5.00	2.99	1.01
I can use a mathematical way of thinking.	86	1.00	5.00	3.19	0.98
I have various ways and strategies of developing my understanding of mathematics.	86	1.00	5.00	3.08	1.02
				3.09	1.00
CK Social Studies (Alpha = .829)					
I have various ways and strategies of developing my understanding of social studies, Geography & History.	88	1.00	5.00	3.39	0.93
I have sufficient knowledge about my subject of specialization.	86	1.00	5.00	3.71	1.06
I can use a historical way of thinking.	87	1.00	5.00	3.44	0.80
				3.51	0.93
CK Science (Alpha = .939)					
I have various ways and strategies of developing my understanding of science.	88	1.00	5.00	3.27	0.97
I can use a scientific way of thinking.	87	1.00	5.00	3.36	0.95
I have sufficient knowledge about science.	88	1.00	5.00	3.23	0.96
				3.29	0.96

CK Language (Alpha = .958)					
I have various ways and strategies of developing my understanding of language.	92	1.00	5.00	3.61	0.91
I can use a literary way of thinking.	92	1.00	5.00	3.59	0.93
I have sufficient knowledge about language.	92	1.00	5.00	3.48	0.91
				3.56	0.92
Pedagogical Knowledge (Alpha = .975)					
I know how to assess student performance in a classroom.	110	1.00	5.00	4.07	0.95
I can adapt my teaching based upon what students currently understand or do not understand.	110	1.00	5.00	3.95	0.98
I can adapt my teaching style to different learners.	110	1.00	5.00	4.00	0.95
I can assess student learning in multiple ways.	110	1.00	5.00	3.97	0.92
I can use a wide range of teaching approaches in a classroom setting.	110	1.00	5.00	3.95	0.94
I am familiar with common student understandings and misconceptions.	110	1.00	5.00	3.88	0.88
I know how to organize and maintain classroom management.	110	1.00	5.00	4.10	0.99
				3.99	0.94
PCK (Alpha = .880)					
I know how to select effective teaching approaches to guide student thinking and learning in my subject of specialization.	110	1.00	4.00	3.62	0.74
I know about technologies that I can use for understanding and doing in my subject of specialization.	110	1.00	4.00	3.53	0.73
				3.91	0.90
TPK (Alpha = .952)					
I can choose technologies that enhance the teaching approaches for a lesson.	110	1.00	5.00	3.71	0.92
I can choose technologies that enhance students' learning for a lesson.	110	1.00	5.00	3.78	0.95
My teacher education program has caused me to think more deeply about how technology could influence teaching approaches I use in my classroom.	110	1.00	5.00	3.74	0.90
I am thinking critically about how to use technology in my classroom.	110	1.00	5.00	3.89	0.98
I can adapt the use of the technologies that I am learning about to different teaching activities.	110	1.00	5.00	3.88	0.92
				3.80	0.93
TPACK (Alpha = .958)					
I can teach lessons that appropriately combine my subject of specialization, technologies, and teaching approaches.	110	1.00	5.00	3.75	0.89
I can select technologies to use in my classroom that enhances what I teach, how I teach, and what students learn.	110	1.00	5.00	3.75	0.94
I can use strategies that combine content, technologies, and teaching approaches.	110	1.00	5.00	3.77	0.91
I can provide leadership in helping others to coordinate the use of content, technologies, and teaching approaches at my school.	110	1.00	5.00	3.57	0.94
I can choose technologies that enhance the content for a lesson.	110	1.00	5.00	3.75	0.91
				3.72	0.92

5. QUALITATIVE RESULTS

The survey questionnaire included three open-ended questions, where the participants were asked to describe the best lesson that they have taught using technology, to describe how participants use technology to differentiate instruction and how technology is used in assessment. Data suggest that teachers predominantly use technology such as power-point presentations and projectors, smart television sets, and using computers with internet for browsing.

5.1 Definition of Technology Integration

Technology integration in teaching was defined in various ways by teacher participants who participated in semi-structured interviews. One component of the definition entailed the different locus of control, from the perspective of the teachers and some from the perspectives of learners. Some of the teachers defined technology integration from the perspective of teaching and some from learning perspectives. For example, a female teacher defined technology from the teaching perspective as:

Technology integration in the classroom means the use of technology in the class while teaching.

A male teacher, defined technology integration as the use of computers and the internet to teach contents in the classroom.

Using computers and various sources from internet to explain concepts in the class.

Exploring teaching through the use of technology like ICT.

Another conception of technology integration was defined from the perspectives of student learning. Some teachers believe that technology integration is predominantly done to improve students' attention, concentration, and engagement in learning activities. Some narratives obtained were thus:

Technology integration can be defined as the use of technology such as computers, internet etc. to create a meaningful learning experience.

Technology integration in the classroom means the use of technology to enhance student learning experience.

Technology integration mean utilizing technological tools in order to enhance learners learning in the classroom setting.

The third conception of technology integration was obtained where teachers used technology to improve the teaching and learning process. This definition entailed successful integration of technology in terms of enhancing teaching as well as learning.

It is a technological approach whereby the teachers and students use ICT tools to enhance learning and make lessons more effective and joyful.

Technology integration for me is using various forms of technologies while teaching and learning in the classroom to enhance efficacy of the lesson objectives.

Teaching with ICT infusion or Technology driven teaching-learning (experiential learning, activity-based learning and learning by doing).

From teacher's point, technology integration can be viewed as the use of laptop and projector for teaching and the internet and YouTube for preparation of lessons. In addition, students should have access to ICT tools (such as tablet, laptop, desktop, smartphones) and facility (internet) for instant use inside the classroom.

Notwithstanding the different conception of technology integration, data suggests that teacher participants understand technology integration in education. Irrespective of the locus of control, technology integration refers to the use to educational technology in the teaching learning process, with the overall objective of enhancing learning outcomes.

Predominant Technologies used: Microsoft Power-point and Projectors.

The majority of the teachers reported using power-point presentations in the class. The Power-point was used in conjunction with projectors to teach the various topics. The power-point slides were either designed by the teacher themselves or downloaded and modified by the teachers before presenting to the students. For example, a male primary science teacher reported that one of his best lessons till date was delivered using the laptop, projector, and the internet and disseminated through a power point presentation. He shared that;

Presenting with PowerPoint slides and used Virtual Lab (Laptop, Projector and Internet service). Three states of matter and it's particles arrangements.

I could use PowerPoint and show videos to transfer certain concepts.

Similarly, a middle school geography teacher shared that power-point presentations was used to deliver a lesson on landforms.

Landforms created by the depositional work of the glacier with the diagrams and videos. Technology- Power point Presentation with diagrams, Quiz and videos. Teaching strategies- Quiz Quiz Trade.

A female teacher with more than 20 years of teaching experiences shared that she has trouble using technology and requires assistance even in developing power-point slides. Perhaps this reinforces the notion of digital natives and digital migrants. She shared the following:

I don't have much knowledge about technology. So, with the help of my friends, I made a PowerPoint presentation.

Besides facilitating the use of Power-Point presentation in whole class instruction, teachers also reported using projectors to present audio-visual materials to the whole class. The audio-visual materials appear to be downloaded from the internet, rather than being created in the majority of the cases.

I have made them to watch a video on the topic dispersion of light and refraction whereby they were asked to take note of whatever they have learned and understood from the video. Then they were asked to share with their group members led by the appointed leader of the group. After the sharing and discussion within the group, the class lastly shared with whole class and eventually all points were captured as a whole through sharing and discussion.

A language teacher shared her narrative of one of the best technologically embedded lesson as:

I taught through alphabet sounds. Videos were played on TV. Teaching approaches I used are active learning, demonstration and gamification.

Yet another language teacher, described her best lesson as;

Teaching grammar topics, using YouTube videos and exploring more on the topic

Another teacher describes her best lesson as:

The best lesson that I could teach using YouTube video lessons on Fluvial erosion. It has helped my students to understand through visualization of the concept taught.

Teaching a concept in science, the best lesson taught using technology was described thus:

Grafting, organic and Inorganic farming etc... grafting techniques from YouTube.

The above narratives indicate that teachers' use of technology in the classroom were limited to the use of computers and projectors. Teachers used power-point presentations to teach academic subjects, in conduction with projects. Teachers also diversified their instructional approaches by projecting audio-visual materials downloaded form the internet, particularly YouTube.

5.2 Using Technology to Differentiate Classroom Instructions

The use of technology in the classroom also enables teachers to differentiate instructions and cater to the variety of students' needs. According to the Association for the Supervision of Curriculum Development [31], education technology integration to differentiate classroom instruction is based on 4-Es: equitable, effective, efficient, and engaging. The use of educational technology in classroom should ensure that the learning needs and styles of all the students are catered to, the use of educational technology should be efficient, effectively enhance student learning, and meaningfully engage students in their learning and activities. To discern how teachers used technology to differentiate instructions, an open-ended question was included in the survey questionnaire.

One of the survey participants appears to have used technology to differentiate classroom instructions effectively. In a class 3 mathematics lessons on prisms and pyramids, the teacher used a number of technological devices such as projectors, tablets, computer simulation and the internet, to teach the concept as well as to explore individually and in groups of two. The participant narrated thus:

I taught a lesson on prisms and pyramids to a third-grade class using various technologies to differentiate instruction. I utilized computer-based simulations and virtual manipulatives to engage students and enhance their understanding. Students were shown interactive 3D models of prisms and pyramids, which allowed them to rotate and explore the shapes from different angles. This hands-on experience enabled them to grasp the concept more effectively. Additionally, I used a projector to display visual representations and videos that explained the properties and characteristics of prisms and pyramids. This visual aid catered to the different learning preferences of students, ensuring that they could engage with the content in a way that resonated with them. To further differentiate the lesson, I provided students with the opportunity to work collaboratively in small groups. I assigned each group a specific prism or pyramid to research using tablets. Students utilized various educational apps and online resources to gather information about their assigned shape, such as the number of faces, edges, and vertices. This approach allowed students to take ownership of their learning deeper into the topic. In conclusion, I effectively differentiated my instruction on prisms and pyramids for a third-grade class by incorporating technology, such as computer-based simulations, visual aids, and tablets. This enabled students to engage with the content in multiple ways and catered to different learning preferences. By providing hands-on experiences, collaborative group work, and access to resources, I ensured that each student had the opportunity to succeed and deepen their understanding of the topic.

A special education needs teacher also used multiple forms of technology to teach student with special needs. Since the students had different, visible learning difficulties due to their disabilities, the teacher appeared to have effectively used technology to differentiate classroom instruction. She shared thus;

I have a class of students with different abilities. While some students learnt to sound out letter others play with letter names, while some students read just pictures others play with the spelling of picture names. This happened only with use of technology like smart TV, smartphones, I use laptops and projectors to present lessons.

On the other end of the continuum, some of the teachers were not able to harness the benefits of technology to differentiate classroom instructions because of the lack of student abilities to use devices such as the computer and the internet. One of the survey participants shared that:

I could not use technology for differentiated instructions as the lower primary students does not have good skill in using online platform. Some of the students can hardly operate the computer.

Some of the teacher participants allowed freedom to students to use different technology platforms to work on different topics, which was perceived to be differentiating classroom instruction.

I have used exploration method with individualized learning in teaching metallurgy. The learning was in an IT lab. The lesson was first taught with same approach to all and later shared many resources to them such as virtual lab, YouTube channel, technique of searching information suited to their standard, shared the websites to get the content of the topic. This helped different learners to explore and learn with their learning ability.

5.3 Challenges in Integrating Technology

The majority of teachers, who were late into the profession did not receive any long-term training on integrating technology in the teaching learning process. However, younger teachers received training during their preservice teacher education programs. These younger teachers also appeared to be more proficient in integrating technology in their classrooms. Similarly, attending professional development programs on technology integration increased teachers' skills and competencies to integrate technology in their teaching.

Teacher Education Programs: Many teacher education programs include coursework on educational technology. This may cover topics such as using interactive whiteboards, educational software, and online resources in teaching.

Professional Development Workshops: Teachers attend workshops and training sessions organized by schools, districts, or educational institutions. These sessions focus on specific tools and strategies for incorporating technology effectively into the curriculum.

I was prepared to integrate technology in my future classroom through a teacher training course at Samtse College of Education. During my training, I received hands-on experience with various educational technologies, learned about effective pedagogical strategies, and explored how to adapt technology to meet diverse student needs.

However, some senior teachers did not have the opportunity to attend such programs and are unable to use and integrate technology in their classrooms. However, one of the senior teachers appeared to be optimistic and was comitted to learn the deficit skills to effectively integrate technology in his teaching. For example, he shared;

We were not introduced to technology integration during training and haven't attended any PD as well. As a result, I am not that well-equipped or technologically sound but then at times I use Geogebra while teaching graphs. However, I am not able to use it fully other than plotting graphs. Therefore, I intend to explore it further and apply in the classroom.

Issues with technical glitches and connectivity problems were also perceived to be barriers and challenges in integrating technology. Similarly, although minimal ICT facilities were available in the school, data suggests that unequal access to the facilities and competition among teachers to use the facilities was a challenge in technology integration.

technical issues like software glitches and connectivity problems, which can disrupt lessons and lead to frustration, as well as the potential for misuse or not using technology effectively.

Schools have only one ICT laboratory with a limited number of computers connected to the internet, and a number of classes want to access the facilities at the same time. There is a sense of competition in booking the ICT lab among the teachers for a particular class.

In addition, the use of technology in the teaching learning process created unequal access between the haves and the have-nots, which was perceived to be a moral challenge for teachers to integrate technology.

Economic Barriers: Integrating technology often involves the purchase of devices, software licenses, and internet connectivity. This can place a financial burden on schools and families. Schools in underfunded areas may struggle to provide adequate resources, while disadvantaged students may fall behind due to the cost of technology.

Access Disparities: Not all students have equal access to technology at home. Those who lack reliable internet access or necessary devices may struggle to complete online assignments or participate in digital learning activities. This disparity in access can lead to unequal learning opportunities.

6. DISCUSSION

Teachers' TPACK levels obtained through this research suggest that teachers were neither extremely proficient nor required a lot of support in to integrate technology, pedagogy, and content knowledge to coherently use it in the teaching and learning process. As a result of which, it appears that teacher's technology integration reflected lower levels. According to Moersch [7], low-quality technology integration occurs when teachers use technology to prepare and deliver lessons, collect feedback, and grade students' work. This research found that the majority of the teachers used technology to deliver lessons through the use of power point slides, used audio-visual materials, and projects to facilitate teaching and learning. In some of the cases, teachers did use technology to differentiate classroom instructions to cater to the needs of the students. The finding is consistent with the findings of Gumbo et al. [32], McGarr [33], Pan and Franklin [34] and Ritzhaupt et al. [35], who also determined that teachers' technology integration were predominantly represented low-levels of integration.

The low-quality technology integration may be explained from teacher education and professional development programs attended by the teachers. While younger teachers had completed modules on technology integration during their preservice teacher education program, both qualitative and quantitative results indicate that the majority of senior teachers had neither completed programs on technology integration during preservice teacher education program nor attended professional development programs. Research in other countries also found that teachers lack of competence and the general lack of training on technology integration was a significant barrier to high-quality technology integration [36-38]. Senior teachers, who were not able to use technology were also called as digital immigrants [39], since they were born in a period when computers and other technologies were non-existent. Due to the rapid advancements in technology, digital immigrants faced challenges in integrating technology in their lives and profession (Darling-Hammond, 2010).

Both first order and second order barriers to technology integration exists with the sample [8]. First order or external barriers, in the form of availability of resources and access exist in technology integration. Similar findings were reported by Abrami et al. [40], Kurian and Ramanathan [41], and Picciano et al. [42]. Second order barriers in the form of teacher attitudes towards technology integration, appears to exist particularly among digital immigrants. Although teachers had a favourable attitude towards technology integration, they were unable to make the best use of available technology and engage in high-quality technology integration. Even in developed economies, such as the United States, teachers were found to have second order barriers to technology integration [43,44].

Other challenges, particular ethical and moral challenges of integrating technology in classrooms also exist in the Bhutanese educational context, particularly digital divide or the differences between have and the have nots [45]. Teachers were concerned about the inequalities emanating from the digital divide that existed between the students, as a result of which teachers may have had to opt for low-quality technology integration. Previous research determined that teachers' knowledge of the digital divide among their students influenced significant differences in teacher's technology integration [46], (Koromos & Wisdom, 2023). Perhaps, it is because of this knowledge that teachers are reluctant to fully integrate technology into their teaching.

7. CONCLUSION AND RECOMMENDA-TION

The TPACK levels of teachers indicate that they were neither proficient nor required assistance in integrating technology successfully. The means of the sub-scales of TPACK was found ranging from 3.09 and 3.99. Younger teachers were more proficient in technology integration compared to their senior colleagues. It may be attributed to the trainings that younger teachers received during pre-service teacher education programs. Both first and second order barriers to technology integrations were determined. Consequently, it was determined that predominantly low-quality technology integration occurs in schools. It is recommended that policies include the development of teachers' TPACK to immensely benefit from technology. Second, it is also recommended that teachers be adequately trained to integrate technology in the teaching. Third, schools in remote settings should be given preferential treatment when providing computer and internet facilities.

8. LIMITATION

A primary limitation of the research was that classroom observations of teachers' technology integration was not conducted. Classroom observations would have allowed for a richer data to corroborate the findings of the study. Future research on teachers' level of technology integration would benefit from observational data.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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