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Exploring Bhutanese primary school teachers' technological knowledge

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Abstract

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Keywords

COVID-19, digital technology, online learning, school closure, technology integration

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Exploring Bhutanese Primary School Teachers' Technological Knowledge

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Abstract

The COVID-19 pandemic has disrupted the normal functions of schools globally. Online learning is a new concept in Bhutan. Nonetheless, classes have begun using various online learning platforms to continue their operations during the pandemic. This study examined primary school teachers' perceived information technology knowledge and proficiency. The participants of this study consisted of 124 primary teachers from two western districts of Bhutan. Data were collected using an online survey. The study's findings suggested that although the majority of participants (98.2%) had access to personal digital devices, slow internet connection and high internet data subscription charges (60.7%) were cited as significant challenges. Findings also revealed that a small percentage of the participants, less than 12 (9.7%) teachers in this study preferred to teach entirely in an online learning environment. The results of multiple linear regression suggested that only technological pedagogical knowledge (TPK) [$t = 2.68, p = .008, \beta = .236$] and perceived information technology proficiency of teachers (PITP) [$t = 3.55, p = .001, \beta = .306$] were statistically significant predictors of technological knowledge (TK).

Keywords: COVID-19, digital technology, online learning, school closure, technology integration

Introduction

The COVID-19 pandemic has forced universities, colleges, and schools worldwide to make modifications to their instructional delivery systems (Zhou et al., 2020). More than ever, the use of technology to leverage online learning has increased dramatically (Adarkwah, 2021; Bergdahl & Nouri, 2020; Hill & Uribe-Florez, 2020). Online education continues to become the primary tool in delivering uninterrupted lessons worldwide (Kerres, 2020; Onyema et al., 2020).

Although there have been many studies that researched the impact of the COVID-19 crisis in educational institutions (Basarmak & Hamutoglu, 2020; Bergdahl & Nouri, 2020; Onyema et al., 2020), it has been found that most of these studies were carried out in developed countries and in higher education settings (Iivari et al., 2020, Kerres, 2020; Thomas & Rogers, 2020). Therefore, there is a need to examine how primary school teachers in developing countries coped with online learning during the pandemic. The aim of this current study was three-fold. First, given the

complete closure of primary schools, this study attempted to examine primary teachers' perception of online learning and its effectiveness. Second, the study sought to understand proficiency levels of the technological skills of primary teachers. Third, this study aimed to predict primary teachers' technological knowledge (TK) from their attitude towards technology (ATT), technical needs (TN), technological pedagogical knowledge (TPK), and finally perceived information technology proficiency of teachers (PITP). Thus, three research questions and the following hypotheses were formulated for investigation.

1. What are primary teachers' perceptions on the effectiveness of online learning, and their recommendations to improve its effectiveness and barriers to teaching in an online learning environment?
 2. What are the primary teachers' proficiency levels of technological skills?
 3. Can the primary teachers' TK be predicted by related factors such as teacher ATT, TN, TPK, teachers' perceived IT proficiency, and problems and barriers?
- H₀ 2.1: Teacher ATT does not affect TK.
 - H₀ 2.2: TN do not affect TK.
 - H₀ 2.3: TPK does not affect TK.
 - H₀ 2.4: PITP does not affect TK.

Literature Review

Past studies have examined the benefits and the positive effects of information communication technology (ICT) integration by teachers in classroom settings (Fu, 2013; Hegedus et al., 2017; Mishra & Koehler, 2006). Most of these studies have shown that ICT integration plays a vital role in maximizing learning, improving student collaboration, increasing interaction, promoting creativity, and supporting students to become self-directed learners. ICT refers to technology that provides access to information through telecommunications, such as the Internet, wireless networks, cell phones, and other communication media (Berg-Beckhoff et al., 2017; Tong et al., 2014). Although, in general terms, the use of technology in teaching and learning is widely accepted to have gathered sufficient agreement in research as a significant predictor of quality learning and education (Hegedus et al., 2017; Kerres, 2020; Koehler & Mishra, 2009; Mishra & Koehler, 2006; Schmidt et al., 2009), there are still others (Koehler & Mishra, 2009) who have contested that technology use in teaching can be problematic when teachers do not possess the correct skills or capabilities to manage system-related problems fully.

Previous studies have also shown that some of the reasons why teachers do not use ICT in the classroom are due to a lack of resources, resistance to change, a lack of time, or a lack of training and support (Aliyyah et al., 2020; Dorji, 2020; Koh et al., 2014; Mishra & Koehler, 2006; Pradana et al., 2019; Tenzin & Bhattarakosol, 2013). On the other hand, some researchers have reported that teacher self-efficacy and their ATT were significant predictors for successful technology integration (Bas & Senturk, 2018; Tenzin & Bhattarakosol, 2013; Yang et al., 2019). Furthermore, several researchers (Chai et al., 2013; Koh et al., 2014; Mishra & Koehler, 2009) contend these factors may also determine ICT use in the classroom, thus becoming either a barrier or an opportunity. In these studies, many researchers have used the Theory of Planned Behaviour Model, popularized by Ajzen (1991), to study the relationship between teacher behavior and their intentions to engage with technology meaningfully. While considering the perspective of teacher

attitude and their technological engagement, researchers have also found that teachers who view technology positively tend to use it more, thus significantly improving the quality of teaching and learning (Garba et al., 2015; Roussinos & Jimoyiannis, 2019; Seufert et al., 2020; Tenzin & Bhattarakosol, 2013; Yang et al., 2019).

Moreover, according to a previous study by Higgins (2003), learning does not occur by merely using ICT in the classrooms, but teachers must also possess knowledge to efficiently integrate in their teaching pedagogy. In a similar vein, Bergdahl and Nouri (2020) iterated that many requirements must be met before online learning delivery can occur. In this regard, Chai et al.'s (2011) study substantiated that teacher integration of ICT in schools tended to develop slowly. Specifically, the use of technology was found to be sporadic. Therefore, individual technical knowledge was an essential precursor for teachers to immerse themselves and effectively use technology in the classroom (Bergdahl & Nouri, 2020; Bingimlas, 2018; Chen & Jang, 2019; Higgins, 2003; Koehler & Mishra, 2009).

Conversely, more recently, researchers like Huber and Helm (2020) and Kerres (2020) have found that many teachers moved quickly and non-systematically into online teaching partly due to the pandemic, which raised quality concerns. In most cases, teaching remotely was triggered by the health concerns surrounding COVID-19, and most often the transition to online learning was a top-down approach with minimal preparation. Thus, it has posed a significant challenge to schoolteachers, both in developed and in developing countries. For instance, although Germany is considered the world's leading producer of high-tech products, it has been found that schools in Germany struggle to implement technological education for their students (Kerres, 2020). Likewise, open educational resources in China have long been used; still, according to Huang et al. (2020), there is a growing need for strategies that support effective online teaching.

In contrast, Finland found the "transition to online learning environment was much easier as both teachers and students have been using technology comprehensively in all the subjects" (Iivari et al., 2020, p. 4). Further, the Organisation for Economic Co-operation and Development (2020) study, based on the Teaching and Learning International Survey from 2018, examined the participating member countries' use of technology before the pandemic arose. They found that 67% of the participants reported they could support student learning using digital technology. In Turkey, 76% of teachers reported they could facilitate online learning; this was slightly higher than the other surveyed countries.

Currently, there is a scarcity of data regarding Bhutan's experiences with online learning in response to the COVID-19 pandemic. Pre-pandemic, teaching and learning was carried out using a traditional face-to-face approach that adhered to a prescriptive syllabus, which was focused more on the examination performance (Sherab, 2013). Students were also banned from carrying electronic devices, such as mobile phones and tablets while in school (Dorji, 2020; Sherab et al., 2017). Once the pandemic began, these rules were abandoned, and there was a push to move instruction online. To help students adjust to online learning, a 40-minute ICT lesson per week was allocated to primary school students to provide TK. Some of the concepts and topics covered in these sessions were: how computer works, introduction to MS Word, basic commands in MS Word, file and folder management, knowledge on web browsers, using search engines, hardware and file management, advanced MS word, email communications, and animate with scratch (Royal

Education Council, 2016a; 2016b; 2016c). The intent of these courses was to help students be successful while learning online.

Methods

This study explored the TK of the primary school teachers. It employed a quantitative approach with a predictive non-experimental survey design (Cohen et al., 2011; Cooksey & McDonald, 2019). The study design was utilized as it provided opportunity to predict primary teachers' TK without manipulation (Johnson, 2001).

Sample

The sample for this study consisted of primary teachers ($n = 124$) from two western districts of Bhutan. A non-probability sampling technique was employed to recruit the participants for this study. In this sampling approach, the researcher selects “individuals because they are available and convenient and represent some characteristic the investigator seeks to study.” (Creswell, 2015. p. 144). The participants were from six schools in two western Bhutan, out of which (83.1%) have Bachelor of Education degree and (16.9%) have primary teaching certificate. The age of participants ranged from 20-47 years and most participants had teaching experience within one to five years. The detailed demographic characteristics are presented in Table 1.

Table 1. Demographics of the Participants

Characteristic	Value Label	N	%
Level of education	Primary Teaching Certificate (PTC)	21	16.9
	Bachelors in education	103	83.1
Gender	Male	64	51.6
	Female	60	48.4
Age	20-25	26	21.0
	26-30	12	9.7
	31-35	35	28.2
	36-40	47	37.9
	41-45	2	1.6
	46-above	2	1.6
Teaching Experience	1-5	40	32.3
	6-10	17	13.7
	11-15	38	30.6
	16-20	29	23.4

Data Collection

The data for this study was collected in May and June 2020 during school closures due to the COVID pandemic. To achieve the intended aim of this research study, 160 primary school teachers from two selected western districts in Bhutan were invited to participate in the study. The Google form link to the questionnaire were shared by the authors and our acquaintances were also requested to share to their friends in their respective school *WeChat* and *Telegram* groups. The Ministry of Education in Bhutan granted the approval to collect data for this study.

Data Source

The survey questionnaire had four parts. Part A gathered personal information of the participants. This included: (a) gender, (b) teaching experience, (c) age, and (d) level of education. Part B had five subsections that examined constructs and items related to technology. Subsection 1—Teacher attitudes towards technology and Subsection 2—TN were collected using the *Quick Teacher Technology Survey* commonly known as QTTS developed by Ruedel et al. (2013) at the American Institutes for Research. The purpose of QTTS was to develop support material for U.S. teachers related to technology use, opinions, and attitudes towards technology integration (Taban, 2021; Trabelsi et al., 2021). The wording of some of the items were modified, and two items were removed, to fit the Bhutanese context.

Subsection 3 measured TK (6 items) and Subsection 4 measured TPK (6 items), using a four-point Likert rating scale (Strongly Agree = 1, Agree = 2, Disagree = 3, Strongly Disagree = 4). These questions on subsections 3 and 4, were adopted from Technological Pedagogical Content knowledge (TPACK) study of the Royal University of Bhutan faculty conducted by Choden and Sherab (2019). Their study was structured in a similar context to this study and therefore, these constructs were used without modification. The TPACK is a theoretical framework for understanding teacher knowledge required for an effective technology integration process (Roussinos & Jimoyiannis, 2019; Yang et al., 2019). TPACK was developed by Mishra and Koehler (2006) based on Shulman's 1986 Pedagogical Content Knowledge model. Thus, it is imperative to define TK and TPK. TK refers to “the knowledge about various technologies, ranging from low-tech technologies such as pencil and paper to digital technologies such as the Internet, digital video, interactive whiteboards, and software programs” (Schmidt et al., 2009, p. 125). TPK refers to “the knowledge of how various technologies can be used in teaching, and to understanding that using technology may change the way teachers teach” (Schmidt et al., 2009, p. 125).

Further, Subsection 5 measured perceived IT Skills (15 items) with a three-point Likert scale (Low = 1, Moderate = 2, High = 3). To determine respondents' perceived IT proficiency, a scale from Umar and Yusoff's (2014) study was adopted with the mean value of .00 – 1.33 (Low); 1.34 – 2.66 (Moderate); and 2.67 – 4.00 (high), respectively.

For the dimensions in part B, we calculated and reported the widely used coefficient alpha, also known as Cronbach's alpha, to measure the internal consistency for each construct and accepted threshold value of $|\gt 0.7|$ was achieved as per the recommendation of Kline (2011). The five subsections in part B are a representation of constructs taken from previous studies in order to study the relationships among the four predictor variables and an outcome variable. Part C of the instrument, which had three questions, perceptions about the effectiveness of online learning, recommendations to improve online learning, and the barriers to teaching in an online learning environment, were extracted from Brooks and Grajek (2020) study titled *Faculty Readiness to Begin Fully Remote Teaching*. The purpose of the Educause research was to help institutions better understand readiness to move teaching and learning online and to provide support to faculty and instructors. In part D, we posed three self-prepared open-ended items. These questions were related and relevant to online learning and teaching using technology, and the questions were a) What is your perception on the effectiveness of online learning? b) What are some recommendations that you have to improve the effectiveness of online learning? c) What are some barriers to teaching in

an online learning environment? The answers to these questions were marked as a required field and without completing this section, the participants could not submit the questionnaire. The purpose of these questions was to provide respondents the choice to further elaborate on their experiences (Creswell, 2015). The second question in Part D was connected to question two in Part C, and such, connections made it possible for the researchers to identify any comments that were not covered by the closed-ended questions (Creswell, 2015). The details of individual dimensions are presented in Table 2.

Table 2. The Description of Questionnaire Instrument

Part	Description	Number of items	Scale	Reliability (Value)
A	Demographics	4		
B				
1	ATT	14	1: Strongly agree - 4: Strongly disagree	.72
2	TN	9	1: Strongly agree - 4: Strongly disagree	.76
3	TK	6	1: Strongly agree - 4: Strongly disagree	.83
4	TPK	6	1: Strongly agree - 4: Strongly disagree	.85
5	PITP	15	1: Low - 3: High	.69
C				
1	Accessibility	1	1: Self - 2: Government	-
2	Effectiveness	1	1: Strongly agree - 4: Strongly disagree	-
3	Preferences	1	1: Completely face-to-face - 5: Completely online	-
D				
	Effectiveness of online learning	1	Open ended	-
	Recommendations	1	Open ended	-
	Barriers	1	Open ended	-

Note. ATT = Attitude towards technology; TN = Technical needs; TK = Technological knowledge; TPK = Technological pedagogical knowledge; PITP = Perceived information technology proficiency of teachers

Empirical Model

While this present study did not employ a direct empirical model related to teacher use of technology, multiple regression based on the dimensions presented in Table 2 under part B was used. The predictor variables identified in the study were ATT, TN, TPK, and PITP. The outcome variable was the TK of teachers. The regression was tested using the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + e \quad (1)$$

$$TK = 1.096 + 0.267 (ATT) + .035 (TN) + .205 (TPK) + .325 (PITP) - 0.146 + e$$

Data Analysis

Descriptive and inferential statistics were calculated for the data. For part A and part B, the responses to these questions were tabulated using frequency counts and percentages. However, for part B, a stepwise multiple linear regression analysis was used to predict teachers' TK from teacher ATT, technical needs, technological pedagogical knowledge, and finally teachers' perceived IT proficiency. A multiple linear regression was found to be appropriate statistical technique for part B as this study had one outcome variable (dependent [DV]) with multiple predictor variables (independent variables [IV]). In this instance, a simultaneous entry of all the predictors at once

was considered. Tabachnick and Fidell (2007) defined multiple regression as “a set of statistical techniques that allow one to assess the relationship between one DV and several IVs” (p. 117). The qualitative data from the open-ended comments were analyzed through identification of themes and patterns (Creswell, 2015), which is provided in a form of a quick summary in response to research question 1 below.

Findings

The results of this study are presented based on the order of the research questions.

RQ1: Primary teachers' perceptions on the effectiveness of online learning, their recommendations to improve its effectiveness and barriers to teaching in an online learning environment

All 124 participants responded to the three open-ended questions embedded within the survey questionnaire. These questions sought respondents' perceptions about the effectiveness of online learning, recommendations to improve online learning, and the barriers to teaching in an online learning environment. This technique was employed because school visits to conduct face-to-face interviews were impossible due to a nationwide lockdown and school closures.

A summary of the responses on these three questions showed that online learning was ineffective given the lack of student participation, lack of access to digital devices, parent's socio-economic backgrounds, and teachers' inadequate knowledge of technology. Further, some of the recommendations to improve the effectiveness of online learning were the need for clear directions, targeted professional development programs, subsidized digital devices that could be paid in installments, and the desire for blended learning education. Also, the teacher participants highly recommended the need for a virtual learning environment learning platform like that used in the colleges of the Royal University of Bhutan. The third question sought responses on some of the barriers to active student online engagement. The teachers felt that inaccessibility to technological devices, lack of proper assessments, lack of student TK, parent's level of income and education, and high internet charges were reasons for inactive student participation in the online learning environments. Furthermore, these responses suggested that although most of the participants (98.2%) had access to personal digital devices, slow internet connection and high internet data subscription charges (60.7%) were cited as significant challenges.

Likewise, data collected which was interpreted using frequency counts suggested that out of ($n = 124$) respondents, 43 (34.7%) teachers felt that online learning was effective, whereas 81 (65.3%) teachers expressed that online learning was not effective. Also, it was found that only 14 (11.3%) teachers owned tablets, whereas 51 (41.1%) teachers had their laptops, and 60 (48.4%) teachers owned desktop computers, while (100%) teacher respondents owned smartphones. Besides these, less than 12 teachers (9.7%) out of 124 teachers who responded to the survey, preferred to teach entirely in an online learning environment, while more than 112 (90.3%) preferred teaching entirely in a face-to-face learning environment.

RQ2: Primary teachers' technology proficiency levels

It was observed that the self-reported proficiency of Bhutanese primary teachers on basic technology knowledge ($M = 2.45$) and internet applications ($M = 2.11$) were at a *moderate* level respectively. The results showed that the *advanced* technology knowledge ($M = 1.12$) of Bhutanese primary school teachers was low. The findings further revealed that the primary teachers had moderate TN ($M = 2.33$), and higher levels of problems were encountered while using technology in an online learning environment ($M = 2.77$). The TK ($M = 1.16$) of teachers was low. However, their ATT ($M = 2.52$) was moderately positive.

RQ3: Prediction of primary teachers' TK based on ATT, TN, TPK, and PITP

A stepwise multiple regression analysis was conducted to predict primary teachers' TK using the variables: ATT, TN, TPK, and PITP. Residuals were independent, as assessed using a Durbin-Watson statistic of 1.69. There was no multicollinearity evidence, as assessed by variance inflation factor values greater than 0 and lesser than the accepted value of 5. There were no studentized deleted residuals greater than ± 3 standard deviations, no leverage values greater than .2, and values for Cook's distance above 1. The multiple regression model was statistically significant in predicting TK [$F(5, 118) = 6.728, p < .001$] as shown in Table 3. The R^2 for the overall model was .222, and the five variables ATT, TN, TPK, and PITP, when taken together, accounted for 22% variation in TK of teachers. The adjusted $R^2 = .189$ is indicative of small size effect (see Table 4).

Table 3. ANOVA Results

Model		SS	df	MS	F	Sig.
1	Regression	4.376	5	.875	6.728	.000 ^b
	Residual	15.349	118	.130		
	Total	19.725	123			

Note. a. Dependent Variable: Technical knowledge (TK); b. Predictors: (Constant), Problems and barriers, Attitude towards technology (ATT), Technical needs (TN), Perceived information technology proficiency of teachers (PITP), Technological pedagogical knowledge (TPK).

Table 4. Multiple Regression Summary

Model	R	R Square	Adjusted R Square	SE Estimate	Durbin-Watson
1	.471 ^a	.222	.189	.36066	1.691

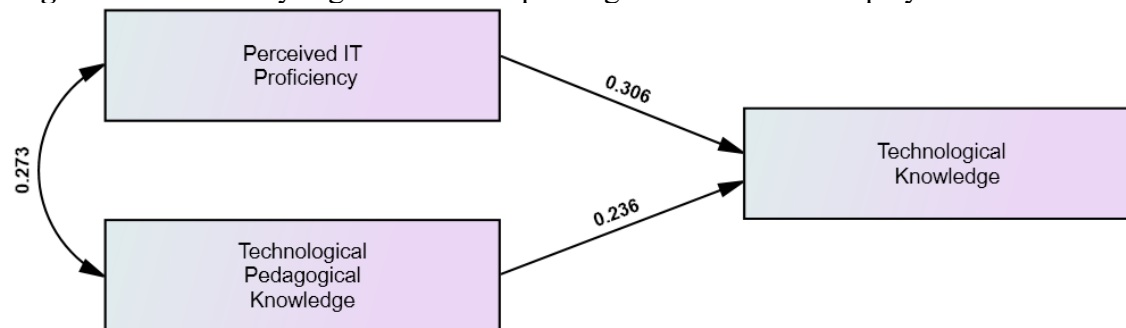
Note. a. Predictors: (Constant); Problems and barriers, Attitude towards technology (ATT), Technical needs (TN), Perceived information technology proficiency of teachers (PITP), Technological pedagogical knowledge (TPK); b. Dependent Variable: Technical knowledge (TK).

The regression coefficients presented in Table 5 suggest that only TPK, [$t = 2.68, p = .008, \beta = .236$] and PITP [$t = 3.55, p = .001, \beta = .306$], were statistically significant predictors of TK. Further, the comparison of standardized regression coefficients, β 's, observe that PITP ($\beta = .306$) has greater influence on TK than TPK ($\beta = .236$). Thus, each standard deviation (SD) increase in PITP will lead to .306 of a SD increase in TK of teachers; whereas, a SD increase in TPK will result in .236 of a SD in TK of teachers. A pictorial representation of the statistically significant regression result is presented in Figure 1. The path model shows only the statistically significant multiple regression in rectangles. The arrows show regression coefficients (β , the standardized coefficients), the correlation between the two statistically significant predictors is represented by the double-headed arrow.

Table 5. Multiple Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	Sig.	Zero-order	VIF
		<i>B</i>	Std. Error	<i>Beta</i>				
1	(Constant)	1.096	.593		1.84	.067		
	ATT	.267	.153	.144	1.74	.083	.19	1.023
	TN	.035	.068	.044	.51	.609	.12	1.112
	TPK	.205	.077	.236	2.68	.008	.33	1.179
	PITP	.325	.092	.306	3.55	.001	.36	1.125

Note. a. Dependent Variable: Technical knowledge (TK); ATT = Attitude towards technology; TN = Technical needs; TK = Technological knowledge; TPK = Technological pedagogical knowledge; PITP = Perceived information technology proficiency of teachers.

Figure 1. Statistically Significant Multiple Regression Results Displayed as a Path Model

Similarly, findings related to the null hypotheses showed that the *first* H_0 : *Teacher ATT does not affect TK*, and the *second* H_0 : *TN do not affect TK* were accepted as no statistically significant relationships were found [$\beta = .144, p = .083$; $\beta = .044, p = .609$; $\beta = -.066, p = .453$] respectively (see Table 5). The *third* H_0 : *TPK does not affect TK* and the *fourth* H_0 : *PITP does not affect TK* null hypotheses were rejected because statistically significant relationships were found [$\beta = .236, p = .008$; $\beta = .306, p = .001$].

Conclusions

This study examined three research questions related to Bhutanese primary school teachers' use of technology to disseminate online teaching during the school closure due to the COVID-19 pandemic. The first part is related to teachers' perceptions about the effectiveness of online learning, recommendations to improve online learning, and the barriers to teaching in an online learning environment.

The results of this study showed that 112 (90.3%) in the sample ($n = 124$) considered face-to-face teaching as their preferred method of instruction. This supports Kamal and Illiyan (2021) findings, who reported that more than 77.5% of teacher respondents in India said offline teaching was better than online teaching. Together, teachers in India and Bhutan seem to perceive that they are not fully prepared to conduct online classes. Similar needs and support for effective online teaching were found in China (Huang et al., 2020), although open educational resources to support virtual learning have long been used. Furthermore, findings of both closed-ended and open-ended items on *effectiveness of online teaching and learning* converged, with majority of the participants stating that online learning was ineffective. In contrast, the Organisation for Economic Co-operation and Development (2020) found in other parts of the world, like Turkey and Finland, that

teachers could facilitate online learning without issue. As reported by Organisation for Economic Co-operation and Development (2020), the ability for a smooth transition in these countries suggests that teacher preparedness and professional development in teacher's use of information technology is an essential precursor to achieving successful transition in the teaching and learning process. In particular, the results of many previous studies also demonstrate a strong positive relationship between professional development and teacher use of ICT in educational environments (Bas & Senturk, 2018; Chen & Jang, 2019; König et al., 2020; Morris, 2010; Roussinos & Jimoyiannis, 2019).

In addition, the results of this study found that teachers in Bhutan had low TK; a likely explanation for Bhutanese teachers' preference for face-to-face learning instead of online learning. This finding is in accordance with the existing literature, which has shown that teachers' TK has a direct relationship with their use of ICT in learning (Koh et al., 2013; Koh et al., 2014; Ifinedo et al., 2020). In Bhutan's case, use of technology in teaching is a recent phenomenon, parents and teachers do not associate digital technology as indicators of quality learning. Thus, teachers prefer to use a traditional face-to-face approach that adheres to a prescriptive syllabus, which is focused more on examination performance (Sherab, 2013). Undoubtedly, there needs to be a shift in the way the curriculum is packaged to better support the IT proficiency of primary teachers. The Bhutanese education system focus should be on pedagogical and content knowledge and on incorporating more technological elements into the curriculum and improving teachers' technology skills.

Similarly, based on these teachers' experiences, some recommendations to improve the effectiveness of online learning in the future included the need for clear cut directions, professional development programs for teachers, subsidized digital devices that could be paid in installments, and the need for blended learning education. Further, the participants in this study highly recommended the need for a virtual learning environment learning platform like that used in the Royal University of Bhutan colleges.

The other findings of this study showed that online learning presented several challenges. Some of the barriers to teaching in an online learning environment were lack of access to digital devices, parents' socio-economic backgrounds, level of parent's education, remote locations of the students, high internet charges, and low network connectivity. Similar problems were conveyed in higher education settings (Choeda et al., 2016; Gautam et al., 2021). Past studies also highlighted several challenges associated with teacher use of technology, and some of the challenges were lack of resources, resistance to change, a lack of time, and a lack of training (Aliyyah et al., 2020; Dorji, 2020; Koh et al., 2014; Pradana et al., 2019; Tenzin & Bhattarakosol, 2013). Other studies (Koehler & Mishra, 2006; Yang et al., 2019) further purported that a lack of support could also contribute to the low TK of teachers who engage in online learning.

The findings related to the second research question suggest that Bhutanese primary teachers' proficiency with basic technology and internet applications were at a *moderate* level, which showed that they had some basic knowledge of word processing and the use of spreadsheets and creating PowerPoint presentations. The results also indicated that the primary teachers needed more technical support to integrate technology in online learning environments. Low technological competency of Bhutanese primary school teachers may be due to lack of technical support, infrastructure (Pradana et al., 2019; Roussinos & Jimoyiannis, 2019) and training (Garba et al.,

2015). Low TK of teachers was reported in several studies across several countries, including Taiwan (Chen & Jang, 2019), Malaysia (Garba et al., 2015) and Indonesia (Pradana et al., 2019).

The third research question was related to primary teachers' TK based on their ATT, technical needs, technological pedagogical knowledge, and the perceived teachers' IT proficiency levels. The findings showed that the primary teachers' TK could only be statistically predicted by TPK and PITP. Further, the results likewise showed that PITP had a significant impact in predicting the TK compared to the TPK of teachers. The results presented here concur with the findings of a similar study on teachers' TK signifying that teachers' perceived ICT capacity or, in other words, PITP outweigh other dimensions (Vitanova et al., 2015). However, Vitanova et al. (2015) also found that teacher attitude towards ICT significantly affected teachers' overall ICT capability.

Nonetheless, our finding in this respect did not match the results of other previous studies where the attitude of teachers towards technology was found to have a significant impact on successful technology integration by the teachers (Bas & Senturk, 2018; Jang et al., 2021 Koh et al., 2014; Tenzin & Bhattarakosol, 2013; Yang et al., 2019). Similarly, while the findings of this study did not find a statistical relationship between TN and TK, past studies had consistently shown TN to have a direct positive influence on teachers' TK (Chen & Jang, 2019; Koh et al., 2013). Furthermore, this study's R Square was .222, which was slightly better than the Baturay et al. (2017) study which reported an R squared value of .166 and was similar to the Vitanova et al. (2015) study which had an R square value of .231. The R square values of these studies corroborate the model within this study.

Implications

This study has implications for policymakers, educationists, curriculum developers, school administrators and teachers. These findings encourage education stakeholders to rethink the use of technology in education and its relevance in creating 21st century learners. Ample and continuous professional development in delivering online classes for teachers needs to be planned. Further, an online learning platform suitable for Bhutan's education system should be used to enhance teaching and learning processes. Teacher training to integrate technology has far-reaching implications for improving the quality of education and providing teachers with adequate technological pedagogical knowledge to deal with unforeseen crises in the future. Further, a shift from an entirely face-to-face prescriptive to a blended learning curriculum may help enhance the TK and practice of teachers. A policy revision on the ban of digital devices by students should also be reviewed by the relevant policymakers to fully reap the benefits of digital skills in schools for both teachers and students.

Limitation and Further Research

Several factors limited this study. First, the data collected were self-reported by the participants. Second, the small sample size limits the generalizability of the study's findings and may therefore not be applicable or representative of the views of other primary teachers throughout Bhutan and abroad. Third, our study did not consider the demographic characteristics (gender, age, teaching experience, teacher qualification) of the respondents in the regression model; if those were considered, it may have accounted for better prediction. Hence, future studies could use demographic variables as a control variable to predict the TK of teachers. While this study

incorporated three open ended questions along with the survey questionnaire, more could be learned about teachers' perceptions of online learning by conducting in-depth interviews.

Not all primary schools provided lessons on ICT, although the ICT curriculum was implemented in 2016 by the Royal Education Council. Therefore, this present study identified several aspects that could be studied in the future. With recent decisions to close levels 7 and 8 from campus education, teachers in the lower secondary schools should be considered for study. Samples could also be extended to classes with 4-6 students. Furthermore, future studies could examine the relationship between cultural context and technology. Lastly, student and parental perceptions of online learning could also be examined.

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