Bhutan Journal of Research and Development
2025, Vol. 14, No. 2, 139-162
https://doi.org/10.17102/bjrd.rub.14.2.008

Teacher Attitudes and Perceptions Toward Technology Integration in Bhutanese Classrooms

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Abstract

This study aimed to analyse the utilisation of technology by Bhutanese teachers and their attitudes and perceptions toward the integration of technology in teaching. It sought to determine the impact of content knowledge, pedagogical knowledge, and technological knowledge on Technological Pedagogical Content Knowledge (TPACK) - the conceptual framework for technology integration in teaching and learning. It employed quantitative non-experimental correlational survey design. The data were collected through a web-based cross-sectional survey from a total of 204 teachers in 19 schools in Thimphu. The findings revealed that while teachers used a variety of devices to support their teaching, Bhutanese teachers rarely utilised web-based applications. The analysis of teachers' attitudes and perceptions toward technology integration showed a combined mean score of 1.74 (± 0.77) on the given scale. A total of 94 (46%) respondents held a negative attitude, 69 (34%) were moderately inclined, and 41 (20%) expressed a positive attitude toward technology integration. The path analyses showed significant direct relationship between content knowledge and technological knowledge to technological pedagogical content knowledge. However, no empirical support was found for pedagogical knowledge. This study highlights a timely and comprehensive national professional development programme and advocates for the establishment of a robust ICT infrastructure in Bhutanese Schools.

Research Article

Keywords
Attitude
Bhutan
Schools
Teachers
TPACK

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Received 17 September 2024
Accepted 21 November 2025

Introduction

The importance of technology in learning has been widely acknowledged, attracting substantial research focus (Al-Fraihat et al., 2020). The use of information and communication technologies (ICT) in schools has significantly increased due to its benefits for both educators and learners (Dhendup & Sherab, 2023; Hegedus et al., 2017). These include enhanced learning experience (Trabelsi et al., 2021), improved collaboration and participation (Tshewang, 2019), and greater student engagement and self-directed learning (Rashid & Asghar, 2016).

Research in Bhutan indicates that teachers' use of technology remains low due to insufficient technological resources in schools, exorbitant internet fees, and a low motivation and training, and fear of technical failures (Dhendup & Sherab, 2023; Dorji, 2021; Tenzin & Bhattarakosol, 2013). These barriers can be addressed through practical training and improved facilities (Norbu & Salleh, 2014; Tenzin & Dorji, 2016). Teachers also avoid ICT in the classroom because of resistance to change, time constraints, and inadequate professional training and support (Aliyyah et al., 2020; Pradana et al., 2019). In contrast, positive perceptions of technology promote greater use and improved teaching and learning (Dhendup & Sherab, 2023; Roussinos & Jimoyiannis, 2019; Seufert et al., 2020).

Shulman's (1986) pedagogical content knowledge (PCK) combines pedagogical knowledge (PK) and content knowledge (CK), yet Choden and Sherab (2019) argue that basic PK and CK alone are insufficient. With increasing reliance on technology, teachers are now required to integrate digital tools to enhance teaching and learning. In response, Mishra and Koehler (2006) introduced TPACK to explain how technology interacts with PK and CK. Research further argues that technology use is essential for promoting cognitive engagement and lifelong learning (Mundy et al. 2012; Rashid & Asghar, 2016).

In Bhutan, policies have consistently encouraged teachers to integrate technology into teaching (Department of Curriculum and Professional Development [DCPD], 2022; Ministry of Education, [MoE], 2020) recognising its potential to enhance learning in Bhutanese schools (Tshewang, 2019). While some studies have explored educational technology in the Bhutanese schools (Dhendup & Sherab, 2023; Tenzin & Bhattarakosol, 2013; Tenzin & Dorji, 2016), empirical evidence on the relationship between TPACK and PCK remains limited. This study examines the relationship by evaluating the effectiveness of TPACK in understanding how teachers use technology and offers insights to inform policy and improve technology-based learning in Bhutanese schools.

This study aimed to investigate Bhutanese teachers' integration of technology in their teaching, including their opinions and attitudes. It also examined how content, pedagogical, and technological knowledge influence TPACK in classroom practices.

Research questions

i. What are the specific technologies used by teachers for teaching and learning purposes?
ii. What are Bhutanese teachers' opinions and attitudes to technology integration in teaching?

iii. How can teachers' TPACK knowledge be predicted by related factors such as Content Knowledge, Technological Knowledge, and Pedagogical Knowledge?
H1. CK has positive and significant effect on TPACK
H2. TK has positive and significant effect on TPACK
H3. PK has positive and significant effect on TPACK

Literature Review

ICT has become integral to teachers' daily work, with technology viewed as an essential necessity (Richards, 2017, p. 253). Often, "educational technology" refers to digital tools, such as computers, which support classroom instruction (Tamim et al., 2011). Consequently, technology use in education has surged (Adarkwah, 2021; Bergdahl et al., 2020; Hill & Uribe-Florez, 2020) and serves as a primary means for delivering uninterrupted lessons (Onyema et al., 2020). ICT literacy and 21st-century skills are also recognised as crucial for productivity in the information society (Groff, 2013).

Over the decades, researchers have highlighted the benefits of ICT integration in teaching and learning (Hillmayr et al., 2020; Körtesi et al., 2022; Olsher & Lavie, 2023). The COVID-19 pandemic further accelerated its use, requiring teachers to adopt remote teaching. In Bhutan, training sessions enabled teachers to access diverse ICT tools and online resources for distance learning. The Ministry of Education and Skills Development's mandates, reflected in the Bhutan Professional Standards for Teachers (BPST, 2020) and online Individual Work Plans, emphasise the critical role of ICT in education.

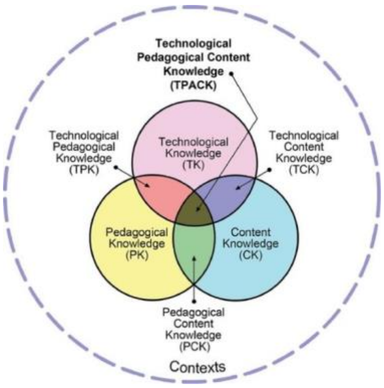
Hamliyah et al. (2024) and Hatamleh et al. (2024) identify key benefits of ICT in teaching, including reduced instructional time (Kaizer et al., 2020), improved teacher-student communication (Liu et al., 2020), higher classroom participation (Alokluk, 2018; Ghosh et al., 2019), and increased academic achievement (Simes et al., 2022). ICT supports constructivist teaching by linking multiple representations (Ball et al., 2018; Drijvers, 2019; Hillmayr et al., 2020), enhancing problem-solving, critical thinking, creativity (Fuchsova & Korenova, 2019; Körtesi et al., 2022), collaboration (Comi et al., 2017), and independent exploration (Segal et al., 2016). Online resources further enrich learning and assist in technology-based assessments (Chien & Wu, 2020; Hoyles et al., 2013). Effective use of ICT in classrooms depends on teachers' TPACK (Mishra & Koehler, 2006; Widyasari et al., 2022). This study employs the TPACK framework to examine Bhutanese teachers' technology use and their attitudes and opinions toward its integration in teaching and learning.

In 1986, Lee Shulman introduced the concept of PCK as a fundamental aspect of teachers' professional knowledge, underpinning the importance of 'knowledge to teach specific subject' besides the CK and PK. Inspired by evolving technology

to support learning, researchers (Koehler & Mishra, 2005; Niess, 2005; Pierson, 2001) extended Shulman's model with technology enhanced knowledge facets.
In 2006, Mishra and Koehler articulated these by introducing TK as a third basic knowledge facet that includes knowledge of technology, including internet and digital media. The TPACK framework as shown in Figure 1 is comprised of three main components: TK, PK, and CK. While TK stands for technological proficiency, which is the ability of teachers to skillfully utilise different types of technology, such as computers, software, and mobile applications, in the educational setting. PK, short for pedagogical knowledge, refers to the specific approach that teachers employ in their teaching methods. It encompasses their expertise in the art of teaching and their understanding of effective instructional strategies. In contrast, the instructors' CK pertains to their level of expertise in the subjects they will teach their students (Koehler & Mishra, 2009).

Figure 1

The TPACK Model



Note: Adopted from Koehler and Mishra (2009)

Other important components of the model are the inter-relationship between the model's knowledge components, namely, TCK, PCK, and TPK. According to Koehler and Mishra (2009), TCK is the understanding of the manner of technology and content to be used in addressing subject matter knowledge in the classroom. TCK helps teachers choose the most appropriate and effective technological tools for the subjects and students. PCK is teachers' pedagogical knowledge of the specific content to be taught. TPK is an understanding of the use of technology for specific purposes. The knowledge of TPK helps teachers to choose the best technological tools to be implemented in classrooms that support their pedagogical practices. The interconnections among the model's knowledge components, referred to as TCK, PCK, and TPK, are integral elements of the model.

To elaborate, TPACK is a conceptual framework developed by Mishra and Koehler (2006), which draws upon the theory of reasoned action proposed by Ajzen and Fishbein (1980). The theory of reasoned action is a widely utilised model in information systems (IS) research for understanding technology acceptance. The TPACK framework posits that technological proficiency is essential for comprehending and interpreting information, even though it is only represented as a conceptual model (Gellersted et al., 2018).

Previous research showed the positive contribution of TPACK to improving students' language skills (Ahmadi, 2018), motivating students to learn (Wu & Wang, 2015), promoting students' intellectual participation (Harris & Hofer, 2011), and improving the quality of instruction (Koh et al., 2017). Based on TPACK's significant role in learning, preparing teachers who demonstrate the skills to integrate technology in the classroom have become a future necessity. They must have the knowledge, skills, and self-confidence to facilitate the TPACK-integrated learning. Several studies have examined teachers' TPACK. Trabelsi (2021) examined the technology-mediated practices of physical education teachers in Tunisia. Their study revealed a lack of involvement in ICT and a limited understanding of TPACK levels. Similarly, Tshewang's (2019) study on Bhutanese science teachers revealed that the teachers possessed a moderate level of knowledge and skills in ICT. In addition, among the total population of 162 teachers, it was discovered that 33 teachers (20%) had a low level TPACK, while 53 teachers (33%) demonstrated an average level of TPACK, and 76 teachers (47%) possessed a high level of TPACK. The analysis revealed that the majority of science teachers in Bhutan exhibited a moderate level of TPACK.

The study conducted by Chai et al. (2011) in Singapore revealed a significant and direct correlation between PK and TPACK among pre-service teachers. However, the initial association between CK and TPACK was found to be insignificant before the technology course commenced. Choden and Sherab (2019) found that there were positive relationships among the TPACK factors, ranging from moderately weak to moderately strong. Zhang and Chen (2022) also reported the similar findings, indicating that teachers' TPACK positively influenced their use of technology.

In contrast, the findings of Al-Abdullatif (2019) suggested that pre-service teachers perceive poor competence in using digital technology for teaching and in integrating TPACK into learning. Similarly, Joo et al. (2016), who conducted a study with South Korean secondary teachers, indicated that preservice teachers' TPACK significantly affected teacher self-efficacy and perceived ease of using technology. In their study, they also found that teachers' TPACK did not have a significant impact on their use of ICT or their intention to use technology in the future. On the other hand, the attitude of teachers to use technology is an important factor in the success of technology use in classrooms. In order to ensure teachers achieve sufficient TPACK skills, policymakers and educational stakeholders must understand teachers' attitudes toward using technology (Joo & Lim, 2018) in classrooms. Teachers' attitude is a crucial aspect that impacts the effectiveness and success of technology integration in education (Wicaksono et al., 2020). The teachers attitude reflects their actual behaviour when interacting with technology (Chou et al., 2019), whether for classroom or non-classroom applications.

However, in the Bhutanese context-especially in school education, the study on teachers' utilisation of technology, their attitudes and opinions to the integration of technology, the impact of CK, PK, and TK on TPACK; and their relationship in teaching and learning process is scarce. For instance, Sherab et al. (2022) surveyed the final-year pre-service teachers to assess TPACK-related needs. Their results showed universal daily internet use, with the majority accessing it multiple times and for extended hours. While social networking, academic research, and messaging were common, major barriers included limited ICT pedagogical integration, inadequate knowledge, and poor connectivity. The findings underscored the urgent need for professional development in blended learning and ICT integration.

While, Pelden and Wangdi (2023) examined pre-service teachers' perceptions of PCK at Paro College of Education. Their findings indicated strong CK, effective integration of pedagogy, and positive improvement strategies. While perceptions and competency were largely consistent, gender differences shaped recommendations for enhancing PCK. Their study highlighted the need to strengthen PCK development with attention to gendered perspectives in teacher education. Pelzom and Norbu (2022) conducted a case study at Royal Thimphu College and found out that the tutors were confident in subject content knowledge but struggled to link concepts to real-life contexts, particularly novices. Prescriptive curriculum design constrained creativity in teaching and assessment. While most employed student-centred strategies, few explicitly applied learning theories. A key challenge identified was students' limited capacity for independent learning, which hindered effective student-centred approaches.

However, in the Bhutanese school context, Wangdi et al. (2023) examined factors influencing teachers' intention to use technology, highlighting that TPACK and facilitating conditions (FC) affected behavioural intentions (BI) only through perceived usefulness (PU) and perceived ease of use (PEOU). Similarly, Dhendup and Sherab (2023) found that while most primary school teachers (98.2%) had personal digital devices, slow internet and high data costs (60.7%) were major challenges. Fewer than 10% preferred fully online teaching, and only TPK and perceived IT proficiency (PITP) significantly predicted technological knowledge. The present study's findings are thus highly relevant for educators and policymakers in Bhutan and similar contexts.

Methodology

This study examined Bhutanese teachers' attitudes and opinions toward classroom technology integration using a quantitative, predictive, non-experimental

Bhutan Journal of Research and Development
2025, Vol. 14, No. 2, 139-162
https://doi.org/10.17102/bjrd.rub.14.2.008

online cross-sectional survey. Aligned with postpositivist and pragmatic principles, the design enables objective measurement, statistical modelling, and identification of predictors without manipulating variables, allowing generalisable, theory-based analysis of factors influencing technology use.

Study participants

In order to gather the required data for this investigation, the study utilised a sample size of 204 teachers from 16 schools located in Thimphu city. The participants for this study were selected using a non-probability sampling method. In this sampling technique, the researcher chooses individuals based on their accessibility and convenience, as well as their ability to represent a specific characteristic that the investigator aims to study (Creswell, 2015). Table 1 displays the aggregated demographic data. In general, the majority of participants had a bachelor's degree in education (43%). Likewise, the largest percentage of participants (29%) belonged to the age group of 40-45, and the majority had more than 20 years of experience in teaching in a traditional classroom environment (34%). The ages of the respondents ranged from 23 to above 51 with an average of 42.1 ± 6.5 years.

Table 1

Demographic Details

Characteristic	Category	N	%
Level of education	PTC	25	12
	B. Ed	88	43
	PGDE	51	25
	Masters	40	19
Gender	Male	44	22
	Female	160	78
Age	20-25	8	4
	26-30	20	10
	31-35	23	11
	36-40	44	21
	41-45	60	29
	46-50	34	16
	51 above	15	7
Teaching Experience	0-5	21	10
	6-10	30	15
	11-15	41	20
	16-20	43	21
	20 above	69	34

Data collection and instruments

The online cross-sectional survey method of data collection was used due to its convenience, and the data collected were quantitative in nature. The survey was structured into three sections to systematically capture different aspects of teacher experiences and perceptions regarding technology integration. Section A consisted of nine questions that focused on specific technology usage, such as digital devices, internet resources, and educational software, allowing researchers to assess the extent to which teachers incorporated these tools in their instructional practices. Section B was based on the Quick Teacher Technology Survey (QTTS) developed by Ruedel et al. (2013) at the American Institutes for Research. The primary objective of this section was to gather teachers' opinions and attitudes toward technology integration, including their confidence, perceived usefulness, and challenges related to using digital tools in the classroom.

Section C consisted of 17 items adapted from a study conducted by Hill and Uribe-Florez (2020), the items are presented in Table 5. These questions further explored teachers' beliefs and behavioural tendencies regarding technology adoption, providing a more in-depth understanding of the psychological and contextual factors influencing their attitudes. Across all sections, responses were measured using a four-point Likert scale, where 1 indicated strong disagreement and 4 indicated strong agreement. This scaling method helped ensure clarity in responses while avoiding a neutral midpoint, thereby encouraging respondents to take a definitive stance on each item. The structured approach of the survey, combined with advanced statistical analysis through Gretl and Statistical Package for the Social Sciences and Analysis of Moment Structure (SPSS and AMOS), provided a robust methodological foundation for examining the role of technology in Bhutanese classrooms.

Data analysis

The software Gretl (version 1.7.1) was utilised to analyse descriptive statistics, including measures such as mean, standard deviation, frequency distributions, and percentages. SPSS AMOS (version 21) was used to generate inferential statistics as it is a powerful tool for structural equation modelling. Descriptive statistics helped in understanding the overall patterns of teacher responses and provided an initial insight into the trends related to technology use in Bhutanese classrooms.

Results

Descriptive analysis

The mean and standard deviation were computed to assess the univariate normality of the data, following the suggestion of Kline (2016). The average for section A, consisting of 9 items, varied between 2.32 and 3.84. The range of standard deviations was between 0.70 and 1.38.

Specific technology use

The data from Table 2 indicates that the highest average score was observed for the utilisation of computers and laptops, with a mean of 3.85 and a standard deviation of 1.01. The analysis of teacher responses revealed that teachers frequently utilised the internet for instructional purposes, as indicated by the mean and standard deviation values (3.84 ± 0.97). The mean score of 3.84 suggests that, on average, teachers reported a relatively high level of internet use in their teaching practices. The standard deviation of 0.97 indicates a moderate level of variation in responses, meaning that while many teachers consistently used the internet for instructional purposes, some reported significantly higher or lower usage. With most responses falling within one standard deviation of the mean, it can be inferred that the majority of teachers incorporated internet resources into their teaching. This finding highlights the growing role of digital tools in Bhutanese classrooms, though the variation in responses suggests that some teachers may face challenges or limitations in accessing and utilising internet-based instructional resources effectively.

Table 2

Specific Technology Use for Teaching (N=204)

Technology description	M	SD	Usage				
			Never	Yearly	Monthly	Weekly	Daily
Internet use for developing lesson plan and ideas	3.84	0.97	0	6	96	27	75
Test preparation	3.19	0.70	5	11	136	44	8
Management Programs for student data	3.25	1.00	10	24	102	40	28
Students' Assessment data & records	3.55	0.86	1	10	105	51	37
Apps for teaching and learning	3.62	0.98	148	35	19	2	0
Mobile phones for teaching learning purposes	3.76	1.07	5	8	92	25	74
Projector/TV/smart board for teaching Learning purposes	3.47	1.02	8	13	101	39	43
Tablets/ipads for teaching learning purposes	2.32	1.38	92	14	58	21	19
Computers/laptops	3.85	1.01	0	7	99	15	83

According to the data, only 8 out of 204 teachers reported using technology on a daily basis to create test questions. The average score, represented by $\bar{x}$±SD, was 3.19±.70. In a similar vein, few educators employed technology for the purpose of managing student data and documenting student assessment. Similarly, 148 teachers did not utilise learning applications, while the use of projectors and mobile phones in teaching was predominantly done on a monthly basis.

One possible explanation for the high usage of computers and the internet is their availability and necessity in schools. Computers have long been integrated into educational institutions, and teachers are more familiar with their functionalities for lesson planning, research, and instructional delivery. The internet, in particular, is an essential resource for accessing digital content, communication, and remote learning. Given the increasing emphasis on technology-driven education, teachers may find these tools indispensable for their daily instructional activities.

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https://doi.org/10.17102/bjrd.rub.14.2.008

Opinions and attitudes to technology integration

Table 3 presents the attitudes and opinions of Bhutanese teachers regarding the integration of technology. The descriptive statistics indicate that the statement, " Students are more motivated" has the highest mean ($\bar{x}$ ±SD=3.35 ± 0.65), followed by "Students create products that show higher levels of learning" ($\bar{x}$±SD=3.26 ± 0.50). It demonstrates that incorporating technology in the classroom has led to a significant boost in student motivation (94.1%) and creating products that show a higher level of learning motivation (94%). Similarly, when asked about their opinion on the use of technology, 98 % of the participants expressed that technology has the potential to improve their teaching skills and transform their teaching methods (Refer to Table 3 for specific information).

Table 3

Opinions and Attitudes about Technology Integration (N=204)

Statement		M	SD	D	A	SA
The use of technology	Students create products that show higher levels of learning.	3.26	1 (.5)	3 (1.5)	141(69)	59 (29)
	There are more discipline problems.	2.66	14(7)	75(37)	82(40)	33(16)
	Students are more motivated.	3.35	4(2)	8(4)	104(51)	88(43)
	Students go to inappropriate websites.	2.84	4(2)	59(29)	107(53)	34(17)
	There is more student collaboration.	3.12	4(2)	17(8)	134(65)	49(24)
I think that	Most technology would improve my ability to teach.	3.46	1(.5)	2(1)	103(50)	98 (48)
	Technology can change the way I teach.	3.43	1(.5)	3(1.5)	108(53)	92(45)
	Students are more knowledgeable than I am when it comes to technology use.	3.20	3(1.5)	27(13)	101(49)	73(36)
	There is too much technological change coming too fast without enough support and training for teachers.	3.30	1(.5)	20(10)	99 (48)	84(41)
	Technology is a good tool for collaboration with other teachers when building unit plans.	3.41	3(1.5)	4(2)	104(51)	93(45)

In contrast, the level of attitude toward technology use presented in Table 4 reveals varying perspectives among teachers. Only 41 teachers (20%) demonstrated a positive attitude toward technology integration, while the majority (79.9%) exhibited either moderate or negative perceptions, underscoring the need for targeted interventions to promote a more technology-friendly teaching environment. There is a notable spread in responses, indicating levels of variation in perspectives as indicated in Table 4, 94 participants (46%) had a negative attitude, 69 (34%) had a moderate attitude, and 41 (20%) had a positive attitude and opinion regarding technology integration.

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Table 4

Level of Attitude Towards Technology Use

		Frequency	Percent
Valid	Negative	94	46.1
	Moderate	69	33.8
	Positive	41	20.1
	Total	204	100.0

The cumulative percentages further illustrate the distribution, showing that 79.9% of teachers have either a negative or moderate perception, highlighting the need for interventions to foster a more technology-friendly teaching environment. The small proportion of teachers with a positive attitude (20.1%) suggests that further support, such as professional development, enhanced infrastructure, and school-based mentoring programmes, could help bridge the gap. The findings highlight the importance of targeted training and policy efforts to encourage a shift toward a more technology-integrated education system in Bhutanese classrooms. By addressing these challenges, educational institutions and policymakers can work towards increasing teacher confidence and enthusiasm for using technology, ultimately enhancing the effectiveness of digital learning tools in schools.

In section C, the skewness and kurtosis normality test were carried out, and the value fell within the recommended range of ±3, as suggested by Kim (2015). The skewness values ranged from 0.01 to -2.05 and kurtosis from -0.03 to 1.45, falling within the acceptable range (refer Table 5). Figure 1 presents a histogram of residuals with a superimposed normal distribution curve, showing a close alignment between the histogram and the curve, which supports the normality assumption of the linear regression models. Additionally, the residuals, as indicated in the plot (N(6.56e-16, 0.357)), are approximately zero, and the standard deviation is 0.35, further confirming that the data distribution approximated normality.

Figure 1

Normality Residual Plot

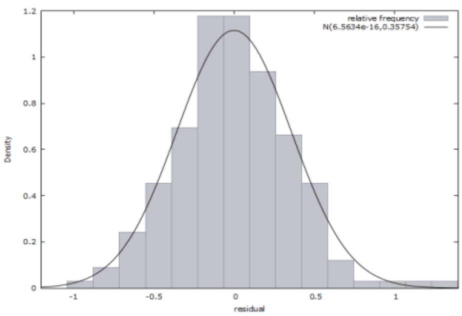


Table 5

Summary Statistics, Using the Observations 1– 204

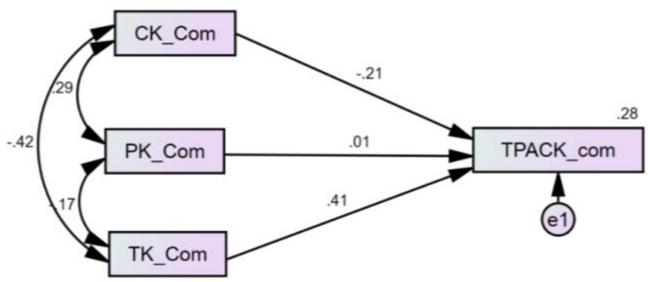
Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Skewness	kurtosis	IQ range
TPACK1	1.74	2	1	4	0.50	-0.12	0.96	1
TPACK2	2.34	2	1	4	0.83	0.01	-0.63	1
TPACK3	1.65	2	1	4	0.65	0.93	1.53	1
TK1	2.16	2	1	4	0.71	0.08	-0.40	1
TK2	1.88	2	1	4	0.62	0.57	1.45	0
TK3	1.93	2	1	4	0.72	0.27	-0.57	1
TK4	2.01	2	1	4	0.74	0.27	-0.39	0
TK5	1.86	2	1	4	0.73	0.52	-0.03	1
TK6	1.54	2	1	4	0.55	0.48	0.25	1
CK1	4.44	4	3	5	0.53	-0.05	-1.32	1
CK2	4.22	4	3	5	0.65	-0.26	-0.74	1
CK3	4.24	4	3	5	0.65	-0.26	-0.70	1
PK1	3.59	4	3	5	0.63	0.60	-0.60	1
PK2	4.75	5	4	5	0.43	-1.15	-0.67	0.75
PK3	4.79	5	4	5	0.41	-1.45	0.12	0
PK4	4.86	5	4	5	0.35	-2.05	2.20	0
PK5	4.77	5	4	5	0.42	-1.31	-0.27	0

Path analysis

Furthermore, the study assessed the normality of residuals to ensure that the statistical assumptions were met. The residuals were found to be approximately normally distributed, suggesting that the model was well-specified and suitable for further inferential analysis. The internal consistency of the constructs was also evaluated using Cronbach's alpha (α), with all constructs scoring above the acceptable threshold of 0.70, confirming reliability and consistency in the measurement scales. With these foundational statistical checks in place, the study proceeded with path analysis to examine the direct relationships and significance of the proposed constructs. Hence, a path analysis was employed to examine the direct relationships and significance of three proposed constructs (refer Figure 2).

Figure 2

Path Analysis



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Prior to estimating the model's path, the assumptions of multicollinearity were evaluated using the Gretl software package. This assessment involved calculating the Kock (2015) method, as well as the variance inflation factor (VIF) and tolerance, to examine the presence of multicollinearity among the variables CK, TK, PK, and TPACK. A VIF (Variance Inflation Fact or) and tolerance are both measures used to assess multicollinearity, as described by Hair et al. (2019). As per the recommendation by Hair et al., VIF values below 5 are considered acceptable (Hair et al., 2019). The collinearity statistics were calculated for the dependent variable TPACK, as shown in Table 6.

Table 6

Collinearity Statistics

Model		Collinearity Statistics	
		Tolerance	VIF
	(Constant)		
1	CK	0.42	2.34
	PK	0.65	1.98
	TK	0.67	2.21

Dependent Variable: TPACK
CK=content knowledge, PK=Pedagogical knowledge, TK= Technological knowledge, TPACK=technological pedagogical content knowledge.

In addition, a composite score was calculated for each item within the construct to generate the VIF. The VIF is displayed in Table 6. The first value represents the VIF, while the second value, enclosed in brackets, represents the tolerance value alongside their respective construct. CK has coordinates (2.34, 0.42), PK has coordinates (1.98, 0.65), TK has coordinates (2.21, 0.67), and there is another point with coordinates (1.91, 0.52). The tolerance value for the four constructs was found to be statistically significant, with a value greater than 0.2. Hence, the computed VIF and tolerance values validate the absence of multicollinearity problems in this study. The internal consistency reliability was assessed by calculating Cronbach's alpha (α). The threshold value is set at 0.70 or higher (Collier, 2020; Kline, 2016). Our reliability scores are as follows: CK (0.78), PK (0.76), TK (0.82), and TPACK (0.84).

Hypothesis testing

We analysed three direct relationships, and the outcomes of hypothesis testing are displayed in Table 7. Among the three hypotheses that were proposed, H1 and H3 were found to be supported, while H2 did not receive empirical evidence and was therefore rejected. The precise estimates (β), critical ratios, and p-value are provided in Table 7 for more information. Using the Gretl programme as an alternative, we conducted a new regression analysis and obtained the same r-square value of .283. The regression model was formulated in the following manner:

$$\hat{}TAPCK = 1.91 + 0.435*TK - 0.208*CK + 0.0141*PK$$
$$(0.513) \quad (0.0698) \quad (0.0685) \quad (0.0936)$$

Table 7

Direct Effects With a 95% Confidence Interval

Relationships	β	t-values	p-value	Decision
1 CK>TPACK	-.207	-3.06	.002*	Supported
2 PK> TPACK	.009	.151	.880	Not supported
3 TK> TPACK	.413	6.28	.001**	Supported
R^2			.282	

Note. Critical ratios are significant at [*p<.05; **p<.001; p < 0.001]; CR (t-values) exceeding 1.96, CK=content knowledge, PK=Pedagogical knowledge, TK= Technological knowledge, TPACK=technological pedagogical content knowledge.

Discussion

This study investigated the specific utilisation of technology by Bhutanese teachers, as well as their attitudes and opinions regarding the integration of technology into the teaching and learning process. The study investigated the impact of CK, PK, and TK on TPACK. One of the findings of this study was that the TPACK could be predicted by CK and TK. The model's predictor variables can account for or explain 28% of the variability in TPACK. The results of this study indicate that alternative measures of PK were not able to adequately account for the prediction of TPACK. This is in contrast to the study carried out by Özgen and Narli (2020), where all CK, TK and PK knowledge constructs are important for TPACK; PK was the highest and TK had the lowest significance level in predicting TPACK.

The demographic characteristics of the respondents, including gender, age, teaching experience, and teacher qualifications, were not included in this part of the path analysis. By not accounting for these demographic variables, the model may have missed potential moderating or mediating effects, which could provide to a certain extent, an understanding of the factors influencing technology adoption. If these characteristics had been included, the predictive accuracy of the path analyses might have improved, offering deeper insights into how different groups of teachers respond to technology. Future research could benefit from incorporating demographic data to explore how individual differences impact technology acceptance, thereby leading to more targeted interventions and professional development programmes aimed at enhancing technology integration in classrooms (Sekhula & Mtotywa, 2025).

Additional results from the study indicated that teachers utilised computers and other digital devices to enhance their teaching and learning experiences. However, a significant number of teachers did not incorporate any web-based applications into their instructional practices, aligning with the findings of Trabelsi et al. (2021). The finding is not unexpected, given that Bhutanese teachers and the education system still adhere to a prescriptive approach in terms of teaching and learning (Dorji, 2021). Further, this finding also aligns with what was reported by Choden and Sherab (2019) where integrating ICT into the curriculum, lack of pedagogical knowledge to use ICT in teaching and learning, and slow and expensive internet connectivity were identified as major problems.

Additionally, concerns about the effectiveness of technology in improving student learning outcomes might contribute to scepticism among educators. The relatively low percentage of teachers with a positive outlook suggests an urgent need for targeted professional development programmes, improved resource allocation, and policy-driven initiatives to foster a more supportive environment for technology adoption in Bhutanese classrooms. The need for immediate professional development aligns with the study carried out by Sherab et.al (2019) in teacher training college in Bhutan.

Furthermore, the current Bhutanese education system, which is primarily focused on addressing pedagogical and content-related issues rather than embracing technological integration, provides a more plausible explanation for teachers' lack of enthusiasm towards incorporating technology (Dhendup & Sherab, 2023). The dearth of experience and expertise, the lack of teacher professional development in ICT, and the absence of infrastructure may all be imminent factors impeding teachers from integrating technology (Dhendup & Sherab, 2023; Kado et al., 2020; Norbu, 2014).

Overall, it was found that the pedagogical knowledge of teachers was inadequate, which could be due to teachers' inability to integrate technology in teaching and learning. These findings suggest that Bhutanese teachers' decision to use technology was not influenced by their understanding of TPACK, as positive and significant results were observed in relation to their CK and TK. It is conceivable that TPACK is not always linked to the intention of utilising technology. The results are in opposition to the conclusions drawn from prior research conducted in this specific field (Yang et al., 2021). Yang et al. found that the TPACK and technology acceptance of K-12 teachers had a substantial impact on their acceptance and intention to use technology. Zhang and Chen (2022) found evidence supporting the notion that teachers' TPACK had a positive impact on their utilisation of technology. This study did not find a positive correlation between the perceptions of technology and TPACK of teachers. The results of our study align with those of Joo et al. (2016), who conducted research involving South Korean secondary school teachers. They found that the teachers' TPACK did not have a significant impact on their intention to utilise technology. In a recent study, Mohammad-Salehi et al. (2021) found that TPACK has a minimal impact on technology utilisation, as also noted by Joo et al. (2018). This apparent contradiction may arise from the absence of web-based learning management systems for the Bhutanese teachers. The same concerns were expressed in the context of higher education (Choeda et al., 2016; Gautam et al., 2021). Additional studies by Koehler and Mishra (2009) and Yang et al. (2019) suggest that inadequate support can also impact instructors' inclination to utilise technology, and the necessity for professional assistance for teachers in Bhutan has been prominently highlighted.

Conclusion

This study investigated the extent to which Bhutanese teachers utilise technology in their teaching, as well as their attitudes and opinions toward technology integration. It also examined the impact of CK, PK, and TK on TPACK. A key finding was that TPACK could be predicted by CK and TK, while PK did not significantly contribute to the model. The predictor variables explained 28% of the variability in TPACK, suggesting that while teachers possess content and technological knowledge, their ability to integrate these into effective pedagogical strategies remains limited. The exclusion of demographic factors (gender, age, teaching experience, and qualifications) in the path analysis may have contributed to this limitation, as these variables could offer a more nuanced understanding of teachers' attitudes and behaviours toward technology adoption.

The study further revealed that Bhutanese teachers predominantly use computers and digital devices to enhance their teaching practices, but web-based applications remain underutilised. The attitude towards technology was predominantly negative or moderate. The low interest in technology adoption could be attributed to insufficient training opportunities, infrastructure limitations, and scepticism about technology's effectiveness in improving student learning outcomes. The teachers' resistance to technology may be influenced by concerns over its potential impact on classroom use, which aligns with broader cultural attitudes toward traditional teaching methods.

It is evident that while Bhutanese teachers acknowledge the presence of technology, their ability to effectively integrate it into pedagogical practices remains a challenge. To address this, there is an urgent need for targeted professional development programmes, improved policy support, and investment in ICT infrastructure to create a more technology-friendly educational environment.

Limitation

This study is subject to several limitations. It is plausible that the findings of this study may not be applicable to different contexts, and they do not necessarily represent the viewpoints of educators employed in Bhutan's rural and remote schools. As a result, the findings must be handled with great caution. Another constraint is the reliance on quantitative data exclusively. However, future studies could employ a mixed methods approach, incorporating interview techniques to gain a more comprehensive understanding of the participants' perspectives.

Future study and recommendations

This study highlights several potential areas for future investigation. Firstly, it is imperative to conduct future research on the correlation between cultural context and technology, as Bhutan's education system is deeply rooted in culture and tradition, which may create resistance to technology adoption. Secondly, the lack of ICT training and professional development remains a major barrier to effective technology adoption, which may lead to low adoption rates and ineffective implementation in classrooms. Future research should explore how structured professional development programmes influence teachers' ability to integrate TPACK into their instructional practices and improve learning outcomes. Another critical factor is infrastructure and accessibility, which are essential for technology adoption. Investigating the impact of infrastructure limitations on technology adoption can help policymakers prioritise investments in technology and connectivity to bridge the digital divide and enhance student engagement.

Lastly, administrative and policy support play a crucial role in driving digital transformation in education. If school leadership and government policies do not actively support technology integration, teachers may receive minimal guidance or incentives to implement digital tools in their classrooms. Future studies might want to examine how policy-driven interventions, incentives, and curriculum modifications can encourage a systematic and sustainable approach to digital learning in Bhutanese schools.

Future research should consider demographic influences on technology adoption, as well as explore interventions that can help bridge the gap between technological proficiency and effective pedagogical application. Without these efforts, the integration of technology in Bhutanese classrooms is likely to remain limited and inconsistent, affecting the broader goal of enhancing digital literacy and 21st-century learning skills.

Acknowledgement

We express our gratitude to the Chief Education Officer of Thimphu City for authorising us to gather the data, which facilitated our undertaking of this study. We would like to extend our genuine gratitude to the teacher colleagues of Thimphu City for their voluntary involvement in the completion of the survey questionnaire. We express our gratitude to the Ministry of Education, Bhutan, for granting approval to our study topic, even though it was in its initial, unrefined state.

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Bhutan Journal of Research and Development
2025, Vol. 14, No. 2, 139-162
https://doi.org/10.17102/bjrd.rub.14.2.008

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