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Primary Science Teachers' Current Practices on the Use of the ICT Tools in Their Teaching-Learning in Tsirang District, Bhutan

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ABSTRACT: This quantitative study investigated the primary science teachers' current practices of ICT tools in teaching primary science in their schools of Tsirang district. The study also aimed to investigate the variations in knowledge, perceptions, challenges faced, and practices of ICT tools based on demographic factors. Data was collected through a survey conducted in 14 primary schools, with a sample size of 92 teachers determined using the Krejcie and Morgan Table. The questionnaire, consisting of 29 items, had a reliable Cronbach's coefficient alpha of 0.85. Data analysis was performed using IBM SPSS v.22, employing descriptive and inferential statistics. The findings revealed a high level of knowledge and perception about ICT tools among teachers, with mean scores of 3.87(SD=.65) and 4.50(SD=.38). Similarly, the use of ICT tools by teachers and challenges encountered were also observed at the high level with mean score of 3.55(SD=.97) and, 3.89(SD=.72). However, there was no significant gender-based differences in knowledge, but found notable distinctions in perceptions. Moreover, the study identified that knowledge, perceptions, and challenges were strong predictors (Model Fit: $R2=.560$, $f(3,88)=6.261$, $p<.05$) of teachers' use of ICT tools in teaching primary science. Future researchers may employ robust designs, like mix-mode research, to delve into teachers' ICT use comprehensively, exploring causation and additional variables.

KEYWORDS: Information Communication and Technology, ICT tools, Knowledge, Perceptions, Practices, Science, Tsirang

INTRODUCTION

Information Communication and Technology (ICT) has influenced many facets of modern life, including education, as a result of the world's dramatic transition from an agrarian culture to a technologically advanced 21st century. ICT offers essential tools for a global perspective (Ministry of Education [MoE], 2019). It eliminates barriers and broadens the range of local, regional, and international learning possibilities for pupils and undoubtedly it has developed into a resource that is essential in the 21st-century. ICT plays a pivotal role in changing the dynamics of teaching and learning and education in a broader sense in a wider range of fields (Kinley et al., 2013). Kachakova (2020) is of the view that ICT potential in education is sometimes viewed as a "Panacea" for virtually all educational issues.

Due to its abundant benefits have shrunk the world creating the information sharing and communication worldwide faster and easier. Significantly, ICT is becoming the everyday language in the world wide. According to Zarabanda (2019), ICT is inevitable and we are unable to do activities without it. Logically, it indicates that the 21st-century calls for 21st-century skills (Dede, 2009). The rapid advancement of ICT has significantly transformed the landscape of classroom instruction all over the world. Integrating ICT into the teaching-learning process motivates students to become adept with technology, empowers teachers to enhance their technological skills, and facilitates the creation of technology-enabled classrooms.

Bhutan, a land-locked country, geographically situated in the Himalayas between two enormous nations remained isolated from the rest of the world including access to technology until late 1990s (Kinley et al., 2013; Tshewang, 2019; Lhendup, 2020). Despite its location, embraces the change and harnesses to leverage the use of ICT at its own pace. With the access open to harness technology, Bhutan expedited National digital network communication service connecting all twenty districts (Kinley et al., 2013). Bhutan embraced the change as a result of the rapid growth of ICT on a global scale that enabled effective service delivery, entrepreneurship, quality of life, simple access to information, and social change (Kachakova, 2020). The underdeveloped countries and those in the verge of bringing change in education system are indebted to COVID-19 pandemic that has evaded educational institutions around the world to change their teaching methods (Karakose, 2021). Similar to this, a significant pedagogical shift has occurred in the teaching-learning procedures in the Bhutanese educational system. Bhutan has only lately started using online

learning. Teachers in Bhutan had to push outside of their comfort zones and use online learning through use of technology to make up for lost class time, just like in many other nations (Dorji, 2020).

Thus far, Bhutan has come a long way since the beginning of education and technology of its immeasurable relevance and the priorities set by the government. It initially experienced both aspects of the situation, at different levels, despite the significant importance it holds. Presently, it maintains optimism for an improved future (Dendup & Sengsri, 2019). Since the inception of the computer application in Bhutan in 1980s (Kinley et al., 2013; Tshewang, 2019; Dorji, 2020; Lhendup, 2020), from teaching pupils the fundamentals of using a mouse and keyboard, now ICT in Bhutan is considered a vehicle for achieving its national objectives of becoming an IT-enabled and knowledge-based society (Dorji, 2020). The then Ministry of Health and Education also initiated the promotion of ICT education in schools in the year 2000 (Phuntsho, 2016; Lhendup, 2020). Likewise, in pursuit of an effective ICT education, a nationwide project, Chiphen Rigpel, was launched in the year 2011 to provide a basic ICT literacy training for all the teachers (Dorji, 2020; lhendrup, 2020). Yet the future still remains open as one essential tool that is expected to convey transferable skills and raise educational standards is the integration of ICT in the Bhutanese classroom (Ministry of Education [MoE], 2019).

Further, the launch of iSherig-2 Education ICT Master Plan 2019-2023, aims in creating citizens "Nationally rooted and globally competent" (MoE, 2019). And further emphasized by His Majesty the King during the National Day, 2020, to generate a "locally rooted and globally competent" citizens. The ministry of education also aimed to achieve "motivation through lifelong learning", "Effective teaching and learning", and "Efficient administration system" through embracing ICT in the education system (MoE, 2019). Thus, Kinley et al. (2013) cautions that Bhutan cannot isolate itself from using ICT in the race for modernization in a larger world context. Even with the difficulties involved in implementing ICT in education, the significance of ICT in education necessitates that educators identify the obstacles to ICT integration into teaching and learning to raise the calibre of instruction (Shadreck, 2015). Bindu (2016) added the incorporation of ICT as a crucial component in the education system.

Anderson (2002) is of view that the use of ICT in scientific curricula is providing several benefits to the learners including the opportunity to work independently and effectively. Learners hone their skills in a range of ICT applications to adapt to technological advancement. According to Lhendup (2020), the use of ICT will be accelerated by ICT education that will equip learners to design systems and products. Given the significance of ICT attached to educating 21st-century learners, it is imperative to understand the current practices of the use of ICT tools in teaching primary science. Since, the present-day learners also exhibit a strong inclination towards digital proficiency and surpass the boundaries of traditional instructors and textbooks to excel in both academics and personal growth, thus, it is imperative to equip teachers with ample knowledge on how to use various ICT tools to create a classroom interactive and enjoyable.

Therefore, this study explored the Primary Science teachers' current practice on the use of Digital or ICT tools in their teaching science. This will address their knowledge on additional ICT tools besides the hardware and gadgets already in use during the classroom instruction. It also highlights the challenges in using ICT tools in teaching primary science.

RATIONALE

This study sought to delve into the contemporary integration of ICT interactive or collaborative tools in primary science instruction, encompassing an exploration of pedagogical practices, perspectives, challenges, and the influence of demographic variables on teachers' adeptness and utilization of these tools. The study's findings hold the promise of shedding light on the intricate interplay between knowledge, perspectives, and practical implementation when employing ICT tools in science education, with potential implications for policy, program design, and professional growth, all aimed at enriching the caliber of primary science teaching. Notably, the pioneering nature of this study, specifically at the primary level, renders it a pivotal endeavor, poised to unveil whether present-day primary science educators seamlessly incorporate ICT tools into their teaching routine.

LITERATURE REVIEW

The 21st-century is the age of technology, during which technology increasingly permeates all aspects of daily life, including the educational system (Kumar, 2008). The world knows the impact of the digital devices and the way the people work with all that equipment. These have brought a great shift from the conventional to the new shift in terms of the entrepreneurships, service delivery, technology and educations. According to Stoddart and Niederhauser (1993), there exists a range of instructional approaches, which vary from traditional to innovative. Similarly, Hernes (2002) points out that the education paradigm created for the Industrial Age is inappropriate for effective educational discourses on teaching and learning in the 21st century world. As a result, it is considered a vital to harness ICT in the education system. Thus**,** Bindu (2016) is assertive that it is a crucial instrument for raising the standard of education.

The needs for ICT in the education system is a paramount element in the teaching and learning process. According to Hernandez (2017), the use of ICT in education is a pervasive reality in society along with "technological tools". As a result, when it is expanded to include students, teachers, and educational institutions, the teaching-learning process will be optimized.

Nevertheless, Hernes (2002) cautions that ICT is not a "substitute for education" in this new paradigm. Similarly, Ritzhaupt et al. (2015) also cautions that the use of ICT tools should not be seen as a replacement for traditional teaching methods, but rather as a complementary tool to enhance student learning and consider that as crucial component of educational model, delivery methods, and curriculum materials. Which in turn, helps students become constructive and collaborative in nature.

Research by Webb (2004), Noor-Ul-Amin (2013) and Ziphorah (2014) validate that the usage of ICT fosters constructivism in students, promotes collaboration, helps students increase their knowledge, and molds their capacity for clear thought. It has been demonstrated that ICT makes learning more dynamic and engaging and gives students additional opportunity to expand their insights through the internet, computers, audio visual content, newsrooms, and other learning aids. Further, the digital devices that Ghavifekr et al. (2016) refer to have created numerous possibilities to use a variety of new technology tools for teaching and learning system. Inspiring students' interest, increasing their engagement, and improving learning and comprehension are all outcomes of using technology in the classroom. The use of digital technology in the classroom today makes it easier to carry out these elements, which are a top priority for all great teachers. ICT contributes to the whole system of knowledge dissemination and learning. The intention of the ICT globally is clear and understood that it has a great impact in the economics, communications, service delivery and education.

Regarding the use of ICT, notably in the sphere of teaching, there has been a tremendous upheaval throughout the world. According to Kanchakova (2020), ICTs reduce inequalities, provide access to free resources, and make the system equitable for everyone who wants to take advantage of it. It has power to change the way that people teach and learn which would convert the education to more appealing and successful for students and result in significant social change.

Many studies have shown that the use of ICT tools in primary science lessons can be effective in improving students' learning outcomes. Studies have also shown that technology-based education can provide more engaging learning experiences for students through tools such as animations, slideshows, videos, and online quizzes (Chigona, 2015; Kanchakova, 2020). For example, a study by Almuslamani et al. (2020) found that the use of educational videos has a direct and positive effect on increasing the students' participation in the classroom as well as their motivation and engagement in learning. Moreover, the use of ICT tools can also enhance students' critical thinking and problem-solving skills.

Factors Affecting the Use of ICT Tools in Teaching Science

Several studies have found that ICT is essential for improving knowledge and skills in general, however there are some identified and perceived obstacles that prevent successful ICT integration in classroom teaching and learning. Although ICT improves and streamlines our work, nevertheless, using technology in the classroom can be difficult for a variety of reasons. The effective integration of ICT faces two problems, according to Donnelly et al. (2011). The first hurdle is referred to as a lack of resources, ***including tools, administrative assistance, and training.*** Teachers' opinions of ICT have an impact on how they use it. Further investigation revealed that the lack of confidence among teachers during the integration process was caused by a variety of factors, including technological issues, a lack of resources, insufficient time for inclusion, and insufficient teacher preparation (Cuban et al. 2001; Jones, 2005 & **UNESCO, 2019**). It is also perceived that the success in implementing ICT-based education is directly associated and influenced by the training or professional development that the teachers went through on the use of ICT tools and resources availability in generating an interactive learning environment that helps in academic achievement and contributes to lifelong learning of the students.

Snoeyink and Ertmer (2001) as cited in Khan et al. (2012) classifies as 'first order' and 'second order' barriers which the first-order barriers refer to the 'lack of equipment', 'unreliability of equipment', 'lack of technical support' and other resource-related issues. Whereas second order barriers include school level factors, such as 'organizational culture' and 'teacher level factors', such as beliefs about teaching and technology and openness to change. Few more to point out such as a dearth of electronic equipment in the classrooms, expensive internet costs, and a lack of teacher enthusiasm and training, have an impact on how well technology is used in Bhutan's educational system. Similar to this, Tenzin and Bhattarakosol (2013) identified the anxiety of handling technological hiccups as a significant impediment. According to Ziphorah (2014), a lack of sufficient training and a fast transition from being a digital beginner to being a digital immigrant may be to blame for teachers' inability to completely integrate technology into the curriculum. Few of the common barriers or challenges in using ICT tools are highlighted below:

i. Qualified ICT Teachers or Teacher-related Variables that Influence or Affect the use of ICT Tools

In Bhutan, access to information and help outside of the classroom is difficult due to a lack of skilled teachers. While many schools have found that workshops or training had little to no effect on teachers' abilities and confidence to utilize ICT in the classroom, some teachers had received some sort of ICT workshop or training. However, it doesn't appear that such training aids in being completely trained and skilled in ICT integration in the field. The majority of teachers may not have much experience with ICT, or practically all teachers may not have any ICT experience at all, since traditional teaching was what the most went under. However, if given significant training on the use of ICT, those teachers are still capable of teaching what learners in the twenty-first century need to know. Followings are the few variables that will have influence to the use of ICT tools.

Teacher's Knowledge, Beliefs and Attitude:

Research has shown that several factors influence the use of ICT tools in science education. One significant factor is teacher knowledge and experience with ICT tools (Chai, Koh, & Tsai, 2010). In addition, teachers who have positive attitudes towards ICT tools are more likely to use them in their teaching (Yoon & Kim, 2017). Furthermore, teacher beliefs and pedagogical practices can also influence the use of ICT tools in science education. Teachers who have a constructivist approach to teaching, which emphasizes student-centered learning and active engagement, are more likely to use ICT tools in their teaching (Barak & Dori, 2009). In contrast, teachers who have a traditional, teacher-centered approach may be less likely to use ICT tools.

The integration of ICT in education depends largely on teachers' attitudes towards its use. Studies by Albirini, 2006; Sim and Theng, 2007, and Mwendwa, 2017 have shown that teachers with positive attitudes towards ICT tools and software are more likely to incorporate them into their instructional process, leading to benefits for students. The teachers' attitudes and perceptions towards ICT integration have a significant impact on its use in education. Despite the potential benefits, challenges such as inadequate access to technology and lack of training exist. To overcome these challenges, professional development programs and policies that promote the integration of ICT into teaching and learning are recommended. The use of technology-based education tools can provide more engaging learning experiences for students.

Gender:

Gender-related variables can have a significant impact on the use of ICT tools in teaching and learning primary science. Research has shown that female teachers are less likely to use ICT tools in their teaching practices than male teachers (Becker & Ravitz, 1999). Similarly, a study by Marcella and Bencze (2013) found that male primary school teachers in Canada were more likely to use ICT tools in their science teaching than their female counterparts. Gender stereotypes and biases can affect the use of ICT tools in primary science education. A study by Naude and Fisser (2011) found that male students in South Africa had greater access to ICT tools than their female counterparts, which may affect their ability to use such tools in science education.

Another research has shown that girls tend to have less confidence in their ability to use ICT tools than boys (Buckingham & Willett, 2006). This may affect their motivation to use such tools in science education and may lead to a gender gap in ICT use in the classroom. It is essential to ensure that gender-related variables are taken into account when designing and implementing professional development and training programs for teachers (Hsu et al., 2017). Such programs should address the unique needs and challenges faced by female teachers in using ICT tools in their teaching practices. To ensure equitable access to and use of ICT tools, it is crucial to address gender stereotypes and biases and to provide teachers with the necessary support and training.

Teaching Experience:

Teaching experience is an important variable that can affect the use of ICT tools in teaching and learning primary science. Experienced teachers are more likely to be familiar with a wider range of ICT tools and more confident in their use (Albirini, 2006). However, teachers' level of experience may not necessarily correlate with their ability to effectively integrate ICT into the curriculum (Ertmer & Ottenbreit-Leftwich, 2010).

Several studies have explored the impact of teaching experience on the use of ICT tools in primary science education. For example, a study by Lee and Tsai (2014) found that experienced science teachers were more likely to integrate ICT tools into their teaching practices, while novice teachers were more likely to rely on traditional teaching methods. Additionally, a study by Cox, Preston, and Cox (1999) found that experienced teachers were more likely to use ICT tools to support collaborative learning activities. Similarly, a study by Wangchuk (2015) also found that experienced science teachers in Bhutan were more likely to use ICT tools in their teaching practices. However, the study also found that many teachers lacked adequate training and support to effectively integrate ICT into the curriculum.

To ensure the effective use of ICT tools in teaching and learning primary science, it is crucial to provide teachers with ongoing professional development and training programs that address their unique needs and challenges (Phuntsho, 2017). Additionally, it is essential to provide teachers with the necessary resources and infrastructure to effectively integrate ICT into the curriculum (Gulbahar & Guven, 2008).

ii. Availability and Accessibility to Infrastructure and Resources

One of the critical factors is the availability and accessibility of ICT tools. Schools with adequate ICT infrastructure and resources are more likely to integrate ICT tools into their teaching practices (Wang et al., 2011). The availability of ICT resources can also impact the quality and effectiveness of science education, as teachers can use ICT tools to provide more engaging and interactive learning experiences for students.

Thus, the availability of computers and Internet access in schools is inevitable. The government has provided numbers of computers under the eDruk project. However, only certain percent of schools may have access to the internet and just over one third teachers may have self-owned computers or laptops. Even those with access to the internet have criticized that it is too slow and unreliable, making it impossible to download or watch YouTube videos and carry out with the interactive activities. Such are the barriers that impact the use of ICT tools in the teaching Science.

iii. Professional Development and Training

Professional development and training play a crucial role in enhancing the use of ICT tools in teaching and learning primary science (Looi, Seow, & Zhang, 2010). The effectiveness of ICT tools in primary science education depends on the level of integration of ICT into the curriculum and the extent to which teachers are trained to use those tools (Gulbahar & Guven, 2008).

Wangchuk (2015) is of view that the professional development and training programs play a significant role in enhancing the use of ICT tools in teaching and learning primary science. To ensure the success of professional development and training programs in Bhutan, it is crucial to tailor the programs to the unique needs and challenges of the Bhutanese education system (Phuntsho, 2017). Unlike in Bhutan, most professional development courses offered in our country did not address the main concerns of classroom realities. Professional development suffers in terms of resources, expertise, time, content and delivery. Although the Ministry of Education encourages professional development programs in ICT, many teachers fail to practice, due to limited resources, heavy workloads and lack of ICT competence to integrate in the subjects. And similarly, inadequate access to technology and insufficient training hinders the effective implementation in the lesson (Ertmer et al., 2012).

Furthermore, the use of ICT tools in teaching and learning primary science in Bhutan can have a significant impact on student learning outcomes and motivation (Wangchuk, 2015). However, it is essential to ensure that the use of technology is integrated into the curriculum in a way that supports and enhances traditional teaching methods (Phuntsho, 2017). The integration of ICT tools in primary science education requires a multifaceted approach that includes teacher training, availability of resources and infrastructure, teacher attitudes and beliefs, and support from school administrators and policymakers. By addressing these variables, teachers can enhance the effectiveness of ICT tools in teaching and learning primary science.

Research Questions

1. What are the primary science teachers' levels of perceptions, knowledge and challenges faced in use of ICT tools in primary schools?
2. Does training received by teachers have significant differences across their perception, knowledge, and challenges faced on the use of ICT tools?
3. Do teachers' teaching experience, school location, knowledge, perceptions, and challenges encountered influence the teachers' usage of ICT tools?

METHODOLOGY

Objectives:

The research objectives are as follows:

1. Assess the levels of perceptions, knowledge, and challenges encountered by primary science teachers in the utilization of ICT tools within primary school settings.
2. Investigate whether the extent of received Professional Development among teachers yield statistically significant differences in their perceptions, knowledge, and encountered challenges concerning the utilization of ICT tools.
3. Examine whether the teachers' usage of ICT tools in classroom teaching is influenced by their teaching experience, School location, knowledge, perceptions, and challenges.

HYPOTHESIS

H_{01}- *There is no statistically significance in regards to teaching between the teachers who received PD and those who did not receive PD on the use of ICT tools.*

H_{02}- *There is no statistically significance between gender on the current Practice of ICT tools.*

Research Design

Under this method design, the researcher has adapted cross-sectional survey design for this study. Further, the study involved defining a clear research question or hypothesis, selecting a sample that is representative of the population of interest, collecting data through structural instruments such as surveys, and analysing the data using statistical techniques. It also involved various statistical techniques to measure and analysed relationships between variables.

Samples:

The sample of 92 teachers (M=66, F=26) participants were chosen from 14 schools under Tsirang district in which, schools were categorized as urban, semi-urban and rural to explore the teachers' current practices on the use of ICT tools in teaching and learning primary Science. The population consisted of the general teachers in the selected district, categorized with mixed genders. Probability sampling technique where Stratified and Systematic random sampling were used. The sample size for this study was determined using Krejcie and Morgan Table (Krejcie & Morgan, 1970).

Tools:

This study gathered data from teachers of 14 Primary schools. As the schools were spread across the district in various geographical location, a web-based questionnaire was used that otherwise have difficulty in collecting data face to face. 92 teachers (M=66, F=26) with 29 items in the questionnaire. Likewise, all the teachers were shared with the google form link through their

principals with due permission from the Chief District Education Officer (CDEO). The study utilized Cronbach's coefficient alpha (1951) to evaluate the internal consistency, which measures the correlation between the scores of each item in the test and the total score for all items in the test, also known as the test index score. The items with high correlation with the test index score are considered highly reliable, whereas those with low correlation values are deemed unreliable and are removed from the test. The Cronbach's alpha value of teachers' questionnaire was 0.85, indicating satisfactory reliability (between .65 – .95) **(Table 01).** The survey tool utilized in this study was crafted by the researcher, drawing from prior literature, findings, and aligning with the study's objectives. As the Likert scale is widely used in educational research, therefore, according to Blaikie (2003), the Likert scale data are treated as both ordinal and interval data. The questionnaire was measured on a five-point Likert type rating scale—1-Strongly Disagree, 2-Disagree, 3-Agree nor Disagree, 4-Agree, and 5-Strongly Agree in all the parts.

Table 01. Reliability Rating Acceptance

Cronbach's Alpha	Internal Consistency
a ≥ 0.9	Excellent
0.9 > a ≥ 0.8	Good
0.8 > a ≥ 0.7	Acceptable
0.7 > a ≥ 0.6	Questionable
0.6 > a ≥ 0.5	Poor
0.5 > a	Unacceptable

Source: Google Internet

Administrations:

The survey data collected from teachers regarding their knowledge, perceptions, current practices, frequency of ICT tools, challenges in using ICT tools were analyzed using Statistical Packages for the Social Sciences (SPSS) version 22. Different statistical measures, such as Descriptive statistics, Reliability Analysis, Independent t-test, Analysis of Variance (ANOVA), Multiple regression, and correlations, were applied to the data. The t-test was used to compare the differences between the teachers' knowledge, perceptions, practice, and Challenges based on demographic variables such as gender, school location, teaching experience, and professional development (PD) received. ANOVA was used to test whether there was a significant difference between the perceptions, knowledge, and challenges of teachers based on their demographic variables. The mean, standard deviation, f-value, and p-value were calculated to determine the degree of difference between the means and the level of statistical significance, respectively (McMillan & Schumacher, 2010; Tshewang, 2015). Independent sample t-test was conducted to determine the hypothesis generated between the dependent and independent variables. Similarly, multiple regression was conducted to check the effect level between the dependent and independent variables, whether the independents variable influence or are a good predictor of the dependent variables.

Nonetheless, the protection of research participants was essential to uphold the integrity and credibility of research, and to promote the well-being and safety of individuals participating in research studies, so keeping in mind the ethical issues, the data were collected successfully without hindrances.

RESULTS

Table 01. Demographic representation of the participants

	Frequency(n)	Valid Percent (%)
Gender		
Male	66	71.7
Female	26	28.3
Teaching experience		
0-5 years	41	44.6
6-10 years	20	21.7
11-15 years	23	25.0

16 years and above	8	8.7
PD undergone		
YES	52	56.5
NO	40	43.5
School Location		
Urban	15	16.3
Semi-Urban	38	41.3
Rural	39	42.4

The table describes the demographic representations of participants based on gender, teaching experience, training or PD undergone and school locations. The majority of participants are male 71.7% (n=66) compared to female 28.3% (n=26). The distribution of teaching experience is somewhat balanced, with the highest number of participants having 0-5 years of experience 44.6% (n=41), followed by 11-15 years with 25% (n=23). Then 6-10 years of teaching experience with 21.7% (n=20). Finally, 8.7% (n=8) participant had the 16 years and above experienced in teaching.

With More than half of the participants have undergone professional development (56.5%; n=52), while 43.5%(n=40) have not. Of the total participants, 15 participants (16.3%) are from Urban school locations. 38 participants (41.3%) are from Semi-Urban school locations. 39 participants (42.4%) are from Rural school locations. The participants are fairly evenly distributed across different school locations, with a slight majority from rural areas.

These demographic insights potentially help in understanding how different factors like gender, teaching experience, PD undergone, and school location are related to or influence the variables being studied in the research.

Figure 01 Representing teachers undergone training or professional development

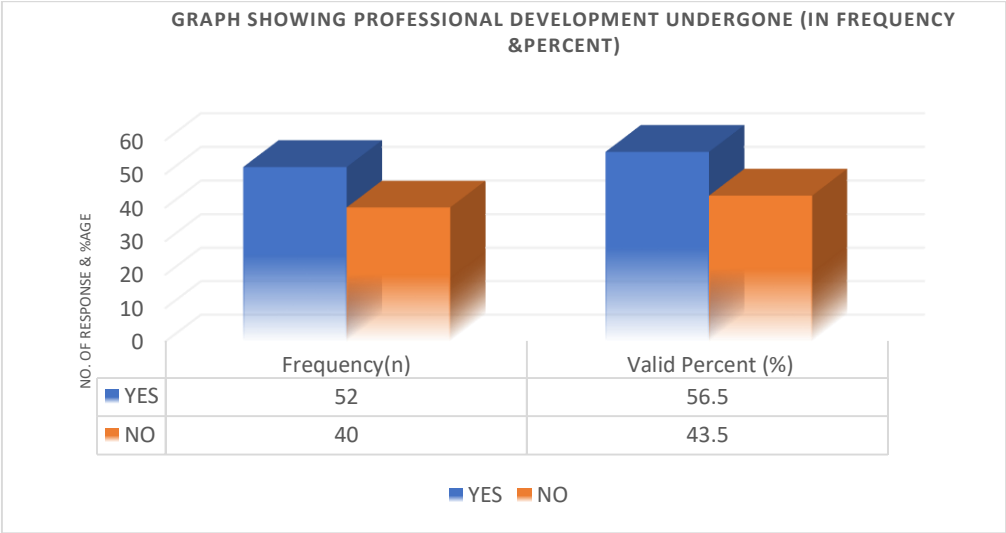

Figure 02 Participants' teaching experiences

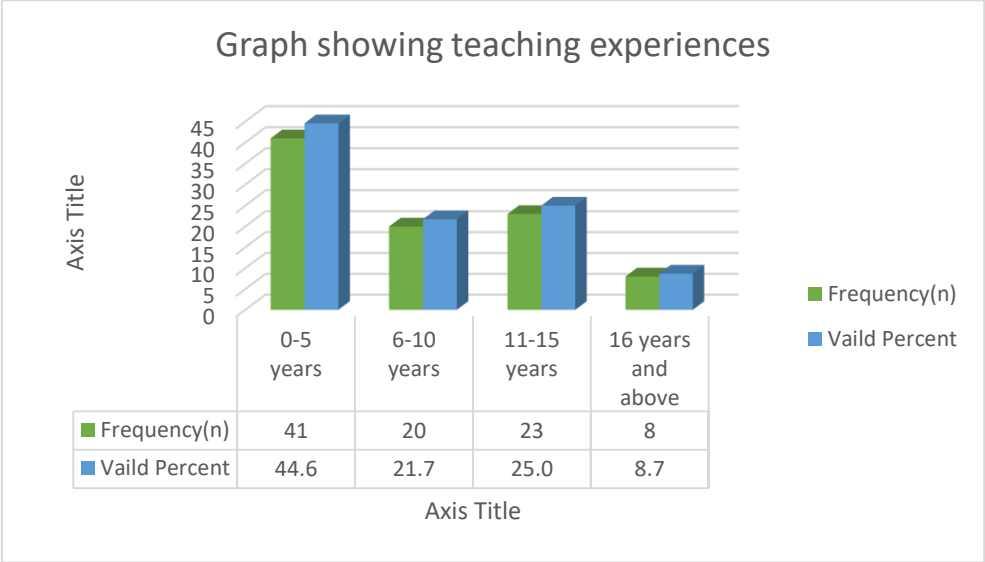

Table 02. Statistical representation of means and SD of the variables in terms of level.

Variables	Mean	Standard deviation (SD)	Level
Perceptions	4.54	.55	Highest
Knowledge	3.87	.89	High
Challenges faced	3.89	1.01	High
Tools usage	3.55	.97	High

Notes: The score of the rating was divided into five levels as the mean score between 4.21 - 5.00 as the highest, 3.41 - 4.20 as a high, 2.61 - 3.40 as a moderate, 1.81 - 2.60 as a low and 1.00 - 1.80 as the lowest (Singye & Leksansern, 2020).

The table 02 highlights the means and standard deviations for the variables "Perceptions," "Knowledge," "Challenges faced," and "ICT tools usage."

Respondents exhibited highly positive perceptions, as reflected by the mean of 4.10. This suggests that, on average, individuals possess a favourable view of the subject matter related to "Perceptions." The relatively low standard deviation of 0.55 implies that these positive perceptions are consistent among participants, resulting in minimal variability in their responses.

Similarly, the mean of 3.87 for "Knowledge" indicated generally high level of understanding among participants. However, the higher standard deviation of 0.89 revealed that there is more variability in knowledge levels. This variability could signify a diverse range of understanding among participants, potentially stemming from different backgrounds or experiences. Further, challenges at a substantial level, as indicated by the mean of 3.89. The larger standard deviation of 1.01 suggests that participants' experiences with challenges vary significantly. This wide variability points to a spectrum of difficulties encountered by different individuals. With a mean of 3.55 for "Tools usage," participants demonstrate a relatively high level of engagement. However, the standard deviation of 0.97 indicates moderate variability in the extent to which participants use tools. This suggests that while overall usage is relatively high, individual habits and preferences vary to some extent.

The participants generally hold positive perceptions and exhibit a high level of knowledge, possibly indicating a strong foundation in the subject matter. They also report facing significant challenges, suggesting a diverse range of difficulties encountered. The relatively high mean for "Tools usage" underscores active engagement, while the standard deviation signifies varied usage patterns. This nuanced analysis provides valuable insights into participants' attitudes and behaviours across these variables, which could be instrumental in understanding their perspectives and shaping interventions or strategies accordingly.

Table 03. Correlations between Perceptions, Knowledge and Challenges on ICT tools Usage

		Perception	Knowledge	Challenges	Tools used
Perception	Pearson Correlation	1	.375**	-.166	.526**
	Sig. (2-tailed)		.000	.114	.000
	N	92	92	92	92
Knowledge	Pearson Correlation	.375**	1	-.137	.670**
	Sig. (2-tailed)	.000		.193	.000
	N	92	92	92	92
Challenges	Pearson Correlation	-.166	-.137	1	.022
	Sig. (2-tailed)	.114	.193		.832
	N	92	92	92	92
Tools used	Pearson Correlation	.526**	.670**	.022	1
	Sig. (2-tailed)	.000	.000	.832	
	N	92	92	92	92

**. Correlation is significant at the 0.01 level (2-tailed).

The presented correlation matrix (Table 03) unveils significant insights into the relationships among perceptions, knowledge, challenges, and practical ICT tool usage. Positive perceptions exhibit robust and statistically significant positive correlations with both elevated knowledge levels ($r = 0.375^{**}$, $p < 0.01$) and increased tool usage ($r = 0.526^{**}$, $p < 0.01$). This signifies that favourable perceptions align with deeper understanding and active engagement. Similarly, knowledge strongly correlates with actual tool usage ($r = 0.670^{**}$, $p < 0.01$), emphasizing its role in practical application. Nevertheless, associations between perceptions or knowledge and challenges show weaker magnitudes and lack statistical significance ($p > 0.05$), suggesting limited influence on challenges. Notably, the correlation between challenges and tool usage is nearly negligible and statistically non-significant ($r = 0.022$, $p > 0.05$), indicating minimal impact on usage.

RQ3*. Do teachers' teaching experience, school location, knowledge, perceptions, and challenges encountered influence the teachers' usage of ICT tools?*

Table 04. Multiple Linear Regression Analysis

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	-1.175	.623		-1.885	.063
	Perception	.541	.120	.341	4.488	.000
	Knowledge	.521	.071	.558	7.360	.000
	Challenges	.130	.060	.155	2.180	.032
	School Location	-.050	.062	-.060	-.813	.419
	Teaching Experience	-.072	.043	-.121	-1.654	.102

Dependent Variable: Tools used

Model Fit: $R2=.583$, $f(5,86) = 24.03$, $p<.05$

The **table 04** shows the multiple linear regression analysis conducted on the relationship between the dependent variable "Tools used" and various independent variables that provides valuable insights into the factors influencing tool usage.

The model exhibits a good fit as evidenced by the coefficient of determination (R^2) of 0.583, indicating that approximately 58.3% of the variance in tool usage can be attributed to the considered independent variables. The P-value for the F-statistic < 0.05 which suggests that the overall model is statistically significant at the 0.05 significance level. Only Perception, Knowledge, and Challenges have significant effects on the dependent variable Tools used, as their associated p-values are below 0.05 ($p < 0.05$).

The standardized coefficients (Beta) indicate the relative strength of the effect of each independent variable. For instance, Knowledge has the strongest effect (Beta = 0.558), followed by Perception (Beta = 0.341), and Challenges (Beta = 0.155). It is suggested that Perception, Knowledge, and Challenges significantly truly influence the teacher's actual utilization of ICT tools. Conversely, "School Location" and "Teaching Experience" exhibit non-significant effects on tool usage due to their p-values surpassing 0.05. Therefore, this analysis underscores the significance of "Perception," "Knowledge," and "Challenges" as predictors of tool usage, offering valuable insights into the collective impact of these variables. Additionally, Positive attitudes (perceptions) towards ICT tools are linked to higher knowledge and more frequent usage. Similarly, higher knowledge about ICT tools is also associated with more frequent usage of ICT tools in teaching science. However, it's important to note that correlation does not imply causation; these relationships only suggest associations between variables.

Table 05. ANOVA test

ANOVA

Tools used

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.026	1	.026	.069	.793
Within Groups	33.507	90	.372		
Total	33.533	91			

The ANOVA test conducted offers insights into the relationship between the variable "Tools used" and different groups. The analysis evaluates whether there are statistically significant differences in the means of "Tools used" among the two gender groups. The F-statistic of 0.069 results from comparing the variability between the group means to the variability within the groups. The associated p-value (Sig.) of 0.793 exceeds the typical significance threshold of 0.05.

Given the high p-value, the data doesn't provide sufficient evidence to reject the null hypothesis, which generally asserts that no significant differences exist between the means of the groups being compared. Therefore, based on this analysis, it's plausible that any observed variability in the "Tools used" variable is likely due to chance rather than meaningful disparities between the groups.

Table 06. Independent Sample Test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Tools used	Equal variances assumed	2.45	.12	-.26	90	.79	-.04	.14	-.32	.24
	Equal variances not assumed			-.30	66.75	.75	-.04	.12	-.28	.21

The Levene's test examines whether the variances of the two groups (gender) are equal. In this case, the Levene's F-value is 2.45, and the associated p-value is 0.12, indicating that the assumption of equal variances is not significantly violated ($p > 0.05$).

The t-test assesses whether there is a significant difference in means between the two gender groups in terms of tools used. For the equal variances assumed case, the t-value is -0.26, with degrees of freedom (df) as 90. The p-value associated with the t-test is 0.79, indicating that there is no statistically significant difference in means between the two groups ($p > 0.05$). The mean difference is -0.04, with a standard error of 0.14, and the confidence interval (95%) for the difference in means ranges from -0.32 to 0.24.

Based on the Independent Samples Test results, there is no significant difference in the usage of tools between the two gender groups. The p-values for both variance equality (Levene's test) and mean equality (t-test) are above the commonly used significance level of 0.05. Therefore, given the current data, gender does not exert a noteworthy influence on how tools are utilized. Failing to reject the null hypothesis aligns with the idea that there is no statistically significant difference between gender groups in terms of "Tools used." So, there is no evidence to suggest that gender has a notable impact on tools usage in this analysis.

Table 07. Item-wise interpretation of challenges encountered

Sl. No.	Items	Data based on Percentage (%) and Frequency (n)							
		SD	D	N	A	SA	M	SD	Level
1	Difficulty in ensuring equitable access to ICT tools for all students in primary science classes deter the use of ICT in my teaching.	7.6% (7)	4.3% (4)	21.7% (20)	38% (35)	28.3% (26)	3.75	1.14	High
2	Technical difficulties and malfunctions with ICT tools during teaching hampers the smooth functioning of my lesson.	4.3% (4)	0	38% (35)	32.6% (30)	25% (23)	3.74	.98	High

3	Learners can't access ICT tools out of school campus even if I use in my lesson.	0	8.7% (8)	26.1% (24)	31.5% (29)	33.7% (31)	2.90	.97	Moderate
4	There is insufficient training and professional development in the use of ICT tools in teaching primary science.	0	17.4% (16)	16.3% (15)	33.7% (31)	32.6% (30)	3.82	1.08	High
5	There is insufficient training and professional development in the use of ICT tools in teaching primary science.	0	4.3% (4)	13% (12)	32.6% (30)	50% (46)	4.28	.86	Highest
	Average						**3.70**	**1.01**	**High**

Notes: The score of the rating was divided into five levels as the mean score between 4.21 - 5.00 as the highest, 3.41 - 4.20 as a high, 2.61 - 3.40 as a moderate, 1.81 - 2.60 as a low and 1.00 - 1.80 as the lowest (Singye & Leksansern, 2020).

Around 38% of participants perceive "Difficulty in ensuring equitable access to ICT tools" categorized "High" level challenge, as a significant deterrent (marked as "Deter"). Moreover, 28.3% strongly agree that this challenge affects their ICT tool usage, which indicates that ensuring equal access to ICT tools is a notable concern. Similarly, approximately 38% of participants agree that technical issues during teaching hinder their lessons, and an additional 32.6% strongly agree, classified as a "High" level challenge. This indicates that a substantial number of educators face interruptions due to technical glitches. Correspondingly, around one-third (33.7%) of participants strongly agree that learners can't access ICT tools outside of school indicating that many educators perceive limitations in students' access beyond the school campus is considered as "moderate" level challenge.

Further, around one-third (33.7%) of participants strongly agree that inadequate training hampers ICT tool integration, and an additional 32.6% agree. This suggests that a significant portion of educators believes that the lack of training is a major obstacle. The challenge is classified as a "High" level challenge with a mean score of 3.82. Interestingly, half (50%) of the participants strongly agree that insufficient administrative support is a big challenge, while 32.6% agree. This underscores the significance of administrative backing as a barrier. The challenge is categorized as the "Highest" level challenge with a mean score of 4.28.

Based on the mean scores and the percentage of respondents who strongly agree, the "Lack of administrative support" emerges as the major deterrent among the barriers. This challenge stands out as the most prominent deterrent due to both its highest percentage of strong agreement and the top-ranked mean score of 4.28, classifying it as the "Highest" level challenge. This suggests that inadequate administrative backing significantly hampers educators' efforts to integrate ICT tools effectively. While all the identified challenges pose hurdles to the integration of ICT tools, the lack of administrative support stands out as the most significant deterrent. This insight emphasizes the need for addressing administrative concerns to facilitate the successful adoption and utilization of ICT tools in primary science education.

DISCUSSION

RQ1. *What are the primary science teachers' levels of practice, understanding, and perceived difficulty in use of ICT tools?*

Teachers' Knowledge of ICT tools in teaching primary science

Having the essential knowledge of ICT is the first and most important step for a teacher to be able to integrate ICT technologies effectively. The integration of ICT tools in teaching primary science has become increasingly important in today's educational landscape. However, the effective implementation of these tools depends largely on the knowledge and skills of teachers. This topic has been studied extensively, and a number of studies have been conducted to investigate the level of teachers' knowledge regarding ICT tools in teaching primary science.

A study conducted by Ertmer et al. (2012) found that teachers lack the knowledge and skills needed to effectively integrate ICT tools into their teaching practices. Similarly, another study conducted by Tondeur et al. (2012) in Belgium found that primary school teachers had limited knowledge and skills in using ICT tools to teach science. The results showed that most of the teachers had a low level of knowledge and skills in using ICT tools to teach science, with only a few teachers having advanced knowledge and skills. Likewise, several studies have investigated teachers' knowledge regarding ICT tools and have found that many teachers lack the necessary knowledge and skills to effectively integrate ICT in their teaching practices (Bingimlas, 2009; Ertmer & Ottenbreit-Leftwich, 2010). For example, a study by Bingimlas (2009) found that although teachers recognized the potential benefits of using ICT tools in their teaching practices, they lacked the necessary skills and training to effectively use ICT tools. Similarly, Ertmer and Ottenbreit-Leftwich (2010) found that teachers often lack the knowledge and skills to effectively integrate ICT tools into their teaching practices, which can lead to ineffective use of ICT tools.

However, the current study refutes the claim that the current teachers in the field lack knowledge about the ICT tools relatively depicts the high knowledge level. Presumably, all the teachers may be having an individual lap top to be used as the situation demands in this 21st century digital world. For instance, a study conducted by Shroff and Vogel (2013) involving 120 primary school teachers in India found that primary school teachers had a moderate level of knowledge and skills in using ICT tools to teach science. The results showed that most of the teachers had a basic knowledge of ICT tools and were able to use them effectively in teaching science. The current study is consistent to Sharoff and Vogel's findings. Similarly, a study by Elhoweris and Alshayeb (2018), primary school teachers in Saudi Arabia had a moderate level of knowledge and skills in using ICT tools to teach science. The study found that most teachers had basic knowledge of ICT tools and were able to use them in their teaching. However, the successful implementation of ICT tools in classrooms is dependent on teachers' knowledge and skills (how competent they are in terms of utilizing ICT tools).

Reliably, the current study aimed to explore the primary science teachers' current practice of ICT tools in their teaching primary science in which the individual knowledge of the subject is as paramount important and related to each other. According to a study by Ertmer and Ottenbreit-Leftwich (2010), there is a strong relationship between teachers' knowledge of ICT and their practice of ICT. The study found that teachers who have a higher level of ICT knowledge are more likely to integrate technology more effectively in their teaching practice, resulting in improved student learning outcomes. Conversely, teachers who lack knowledge and confidence in using ICT may struggle to incorporate it into their teaching practice, resulting in missed opportunities to enhance student learning (Ertmer & Ottenbreit-Leftwich, 2010). Further, the current study found that the level of knowledge on the use of ICT tools of teachers in Tsirang district of fourteen schools have high knowledge level (M=3.87, SD=0.89). The level of teachers' knowledge regarding ICT tools in teaching primary science varies across different countries and contexts. However, most studies suggest that teachers have a limited knowledge and skills in using ICT tools to teach science, and more efforts are needed to provide teachers with training and support to effectively integrate ICT tools into their teaching practices.

Nevertheless, teacher training and professional development programs have been found to be effective in improving teachers' knowledge and skills in using ICT tools (Angeli & Valanides, 2009; Ottenbreit-Leftwich et al., 2010). For example, Angeli and Valanides (2009) found that a professional development program that focused on the integration of ICT tools in teaching practices significantly improved teachers' knowledge and use of ICT tools.

It is therefore important to provide teachers with the necessary training and support to effectively integrate ICT tools in their teaching practices and enhance their knowledge.

Teachers' perception on the use of ICT tools in primary school science

The successful integration of ICT tools into teaching depends on teachers' perceptions and attitudes towards their use. The teachers who hold favourable attitudes towards ICT tools and software are more inclined to integrate them into teachers' teaching methods. As a result, students may derive benefits from such incorporation (Albirini, 2006; Sim & Theng, 2007; Mwendwa, 2017). A study by Law et al. (2008) found that teachers' beliefs about the usefulness and relevance of ICT tools in their teaching practices influenced their knowledge and use of ICT tools. According to Dorji (2020) is of view that, the use of technology by teachers has remained relatively low in Bhutan's educational system, despite a shift toward ICT-mediated teaching and learning practices. The study by Keengwe and Onchwari (2009) in the United States found that primary school teachers had a positive perception of using ICT tools in teaching primary science. The study, which surveyed 101 primary school teachers, found that most teachers believed that the use of ICT tools would enhance their teaching and improve their students' learning outcomes.

Consistently, the current study also found that teachers from the 14 primary schools in Tsirang, surveyed to 92 primary science teachers have a positive perceptions level with the highest mean score (M=4.54, SD=.55). It is evident from these studies that primary school teachers have a positive perception of using ICT tools in teaching primary science. It is backed up by the fact that using ICT tools allows students to participate in cooperative learning activities and encourages teamwork. Similarly, based on studies by Liton (2015), Zinan and Sai (2017), and Tristiana and Rosyida (2018), students had good opinions of ICT-based teaching and learning across a variety of subject areas. The use of technology in the classroom was well received by the students and had a more beneficial effect on their learning environment than traditional pedagogy did (Albirini, 2006).

Nevertheless, the difficulties including limited access to technology and a lack of training may make implementation less successful (Kwame & Appiah, 2022; Ertmer et al., 2012; Law et al., 2008). The study also found that teachers faced several challenges in using ICT tools, such as a lack of resources and technical support, and lack of training and support (Keengwe & Onchwari, 2009). Professional development initiatives and regulations that support ICT integration in teaching and learning are advised in order to address these issues. To effectively integrate ICT tools into teaching, teachers need adequate training and support, as well as access to resources. With proper training and support, primary school teachers can enhance their teaching and improve their students' learning outcomes through the use of ICT tools.

Teacher's practice of ICT tools in teaching primary science

Sl. No.	Items	Data based on Percentage (%) and Frequency (n)							
		SD	D	N	A	SA	M	SD	Level
1	I regularly use digital tools such as interactive whiteboards and projectors in my primary science classes.	0	13% (12)	20.7% (19)	46.7% (43)	19.6% (18)	3.73	.93	High
2	I use digital assessment tools such as quizzes and surveys to assess students' learning in primary science.	0	17.4% (16)	19.6% (18)	42.4% (39)	20.7% (19)	3.66	.99	High
3	I use social media platform such as; WeChat, Telegrams, WhatsApp, Twitter and Messenger to communicate, assign or discuss with parents and students.	4.3% (4)	13% (12)	21.7% (20)	37% (34)	23.9% (22)	3.63	1.12	High
4	I incorporate online educational games and simulations in my primary science lessons to enhance learning.	8.7% (8)	7.6% (7)	38% (35)	32.6% (30)	13% (12)	3.34	1.08	Moderate
5	I use multimedia resources such as videos and animations to supplement my science lessons.	0	4.3% (4)	13% (12)	37% (34)	45.7% (42)	4.24	.89	Highest
6	I use drawings and graphics to teach science, eg: MS paints.	0	4.3% (4)	27.2% (25)	46.7% (43)	21.7% (20)	3.86	.81	High
7	I use different types of software such as; H5P, Hot potatoes, Socrative, Camtasia, etc. to make the lesson livelier and more interactive.	16.3% (15)	20.7% (19)	50% (46)	8.7% (8)	4.3% (4)	2.64	1.00	Moderate
8	I regularly use online collaboration tools to promote collaboration and communication among students in primary science classes.	8.7% (8)	4.3% (4)	42.4% (39)	37% (34)	7.6% (7)	3.30	.99	Moderate
	Average						**3.55**	**.98**	**High**

The use of ICT tools in teaching primary science is not only dependent on teachers' knowledge and perceptions but also their practices. According to studies by Chigona (2015) and Kanchakova (2020), technology-based education can give students more engaging learning opportunities through tools like animations, slideshows, movies, and online quizzes.

The current study results showed that the majority of teachers used ICT tools such as the internet, educational software, and multimedia resources in their teaching. However, the use of more advanced ICT tools such as virtual labs and soft wares (Hot Potatoes and H5P) were found to be limited. This indicates that the teachers in Tsirang district overwhelmingly use ICT tools in their teaching frequently. This is proven through the current data collected in the afore table. Similarly, the study also revealed that the teachers' use of videos and animations (82.5%, n=63), followed by interactive white board and projector (66.3, n=61%) and drawing and graphics (68.4%, n=63) show a highly practiced. And further, the use of digital assessment tools and social media platform (63.1%, n=56), online games and simulation (45.8%), and online collaboration tools (45.6%, n=42) seem highly emphasized. However, the least used tools were observed to be the software (such as H5P, Hot Potatoes…) with 13%(n=12), where 50%(n=46) of the respondents remained neutral (**Table 15**). This indicated that either they were not trained to use it or have no concepts of what software are.

Challenges in using ICT tools in teaching Science

RQ2*. What are the challenges faced by teachers while incorporating ICT tools in teaching-learning primary science?*

Numerous studies have highlighted the crucial role of ICT in enhancing knowledge and skills among students. However, despite its potential benefits, there are certain obstacles that hinder the successful integration of ICT in classroom teaching and learning, as identified and perceived in various studies. Despite the benefits of using ICT in improving efficiency, incorporating technology in classroom instruction can pose challenges for various reasons. Donnelly et al. (2011) mentioned two problems, first hurdle; lack of resources, including tools, administrative assistance, and training. It is also revealed that the lack of confidence among teachers during the integration process was caused by a variety of factors, including technological issues, a lack of resources, insufficient time for inclusion, and insufficient teacher preparation (Jones, 2005). Gulbahar and Guven (2008) insist that to successfully integrate ICT into the curriculum, it is critical to give instructors the tools and infrastructure they need.

Snoeyink and Ertmer (2001) as cited in Khan et al. (2012) classified challenges as 'first order' and 'second order' barriers. 'Lack of equipment', 'unreliability of equipment', 'lack of technical support' and other resource-related issues fall under first order barriers. Whereas second order barriers include school level factors, such as 'organizational culture' and teacher level factors, such as beliefs about teaching and technology and their mind-set. Further, Ertmer and Ottenbreit-Leftwich (2010) supports the availability of resources and infrastructure, teacher attitudes and beliefs toward ICT, and the level of support offered by school administrators and policymakers are a few other factors that, in addition to training, influence the use of ICT tools in primary science education. It is also said that teacher proficiency and expertise with ICT technologies is one important element (Chai, Koh, & Tsai, 2010). It is paramount for teacher education programs to provide opportunities for teachers to develop their ICT knowledge and skills, and to ensure ongoing professional development to keep up with the rapid changes in technology (Ertmer & Ottenbreit-Leftwich, 2010). Similarly, Phuntsho (2017) asserts that it is essential to offer teachers ongoing professional development and training programs that meet their specific needs and challenges if ICT tools are to be used effectively in primary science teaching and learning. Nevertheless, the use of ICT tools should not be viewed as a substitute for conventional teaching methods, but rather as an additional tool to improve student learning (Ritzhaupt, Hohlfeld, & Barron, 2015). Similarly, Hernes (2002) also emphasizes that ICT should not be seen as a mere replacement for education in the current paradigm. Instead, they play a vital role as an integral part of the educational model, delivery methods, and curriculum materials. By incorporating ICT, students are empowered to become active participants who construct knowledge and engage in collaborative learning. This is a crucial point to be noted. The use of ICT technologies in primary science teaching and learning can be significantly improved through professional development and training programs too (Wangchuk, 2015).

It is obvious that while teachers may have a certain level of knowledge and perceptions regarding the use of ICT tools in teaching primary science, their practices play a crucial role in determining the effectiveness of integrating ICT tools into teaching. However, the study also found that the integration of ICT tools into teaching was not always effective, and there was a need for more support and training to enhance teachers' practices in using ICT tools. Additionally, the current study recorded that teachers have significant barriers to using ICT tools. There are many factors associated with that may influence the effective use of ICT tools.

Firstly, the *role of teachers* in integrating ICT tools into education cannot be overstated. Research underscores the significance of teacher knowledge, attitudes, and beliefs regarding ICT tools (Chai, Koh, & Tsai, 2010). Positive attitudes towards these tools tend to correlate with increased utilization in teaching practices (Yoon & Kim, 2017). Moreover, teachers' pedagogical approaches also play a role; those embracing constructivist methods are more likely to incorporate ICT tools (Barak & Dori, 2009). The integration of ICT in education hinges on teachers' attitudes and perceptions, which, although promising, can be impeded by challenges like inadequate access and training (Albirini, 2006; Sim & Theng, 2007; Mwendwa, 2017). Addressing these challenges requires comprehensive professional development programs and policies that encourage ICT incorporation into teaching and learning. Utilizing technology-based educational tools can create more engaging learning experiences (Hsu et al., 2017).

Secondly, the usage of ICT technologies in primary science teaching and learning can be significantly impacted by gender-related factors too. Studies indicate that female teachers might be less inclined to employ ICT tools compared to their male counterparts (Becker & Ravitz, 1999). In a similar vein, Marcella and Bencze's (2013) study discovered that male primary school teachers in Canada were more likely than female colleagues to employ ICT resources in their scientific instruction.

The study by Buckingham and Willett (2006) also found that, girls typically lack the same level of confidence in their abilities to use ICT tools as boys do. This could undermine their desire to employ such technologies in science instruction and result in a gender divide in the usage of ICT in the classroom. When developing and putting into practice professional development and training programs for teachers, it is crucial to guarantee that gender-related characteristics are taken into account. Such initiatives must take into account the particular requirements and difficulties faced by female educators when utilizing ICT in the classroom. The usage of ICT technologies in primary scientific teaching and learning can be significantly impacted by gender-related factors. Gender stereotypes and biases must be addressed, and instructors must receive the required assistance and training in order to promote fair access to and use of ICT resources (Naude & Fisser, 2011). In designing professional development programs, a focus on addressing these gender-based challenges is pivotal (Hsu et al., 2017).

Thirdly, the *role of teaching experience* in utilizing ICT tools is complex. While experienced teachers might be more familiar and confident with these tools (Albirini, 2006), their capacity to effectively integrate them into curricula can vary (Ertmer

& Ottenbreit-Leftwich, 2010). Notably, experienced science teachers are more prone to integrate ICT tools into teaching practices (Lee & Tsai, 2014). Conversely, the current study also did not see any significant difference in varied use of ICT tools by the teachers based on teaching experience. It was found that all the teachers use ICT tools despite their number of years being in the system rather have exceptionally high level of ICT tools usage **(table 02),** Yet, the study did not focus on what types of ICT tools are being used by an individual. Nevertheless, they might require additional training and support for effective integration (Wangchuk, 2015). The professional development programs that cater to the specific needs and challenges of experienced teachers are essential for optimizing ICT tool utilization (Phuntsho, 2017).

Similarly, the *availability and accessibility of ICT tools* significantly influence their incorporation into teaching practices. Adequate ICT infrastructure and resources facilitate integration (Wang et al., 2011). In the Bhutanese context, although efforts like the eDruk project have provided computers to some schools, challenges access, hindering the effective utilization of ICT tools in science education. For example, the teachers face technical difficulties of malfunction and limited access to ICT tools, hardware and medias hamper their teaching in the class with 58.1% (n=53) respondents agree to the statement. The data also highlights that there is extreme difficulty with 66.3% (n=61) in ensuring equitable access to ICT tools for all students in primary science classes which deters the use of ICT in their teaching. 82.6%(n=76) teachers excerpt that students do not have proper gadgets at home to explore what is learned in the class, despite teaching using ICT tools. It is also learned why teachers fail to teach using ICT tools in the classroom; "Learners can't access ICT tools out of school campus even if I teach in the class" has 65.2% (n=60) respondents for the statement. Indicating that students either are not able to revisit or access what is learned in the classroom due to digital divide and other unforeseen factors.

Further, *Professional development* and *training also play* a pivotal role in enhancing ICT tool use in teaching and learning (Looi, Seow, & Zhang, 2010). In this study, access to information and help outside of the classroom is difficult due to a lack of skilled teachers. According to Ziphorah (2014) it may be due to lack of sufficient training and a fast transition from being a digital beginner to being a digital immigrant may be to blame for teachers' inability to completely integrate technology into the curriculum. It is also consistent to the findings of Ziphorah (2014) that insufficient training and professional development in the use of ICT tools in teaching primary science impede it (M=3.89, SD=1.01). The availability of computers and Internet access in schools is inevitable. The effectiveness of these tools depends on their integration into the curriculum and teacher training (Gulbahar & Guven, 2008). Customizing professional development programs to the unique needs of the Bhutanese education system is vital for their success (Phuntsho, 2017). Similarly, challenges such as limited resources, heavy workloads, and inadequate training hinder the implementation of ICT tools in other contexts (Ertmer et al., 2012).

So therefore, the integration of ICT tools in primary science education is a multifaceted endeavour that demands attention to teacher training, availability of resources, attitudes, and administrative support. By addressing these variables, teachers can effectively harness the potential of ICT tools to enhance teaching and learning outcomes (Wangchuk, 2015; Phuntsho, 2017).

RECOMMENDATIONS

The study recommended that more and necessary training and support to be provided to effectively integrate ICT tools in their teaching practices and enhance their knowledge.

The study also revealed that with proper training and support, primary school teachers can enhance their teaching and improve their students' learning outcomes through the use of ICT tools. And also emphasizes the need for addressing administrative concerns to facilitate the successful adoption and utilization of ICT tools in primary science education.

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