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Effectiveness of information communication, and Technology (ICT) tools in teaching mixture in grade seven science in one of the schools in Bhutan

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Article Info

Abstract
The emergence of Information and Communication Technologies (ICTs) has brought about a significant shift in the way lessons are delivered and learners are engaged in their learning process. The integration of ICT tools into science education has been shown to improve the overall quality and efficacy of instructional practices. This quantitative study investigated the effectiveness of integrating ICT tools such as an overhead projector, internet, and smartphones into the teaching of grade seven science in one of the schools in Bhutan. The results of the descriptive analysis revealed a mean difference between the two tests was 9.82. The inferential analysis indicated a significant mean difference between the two tests with ($p < 0.05$, $d = 0.813$), suggesting that the incorporation of ICT tools was effective in teaching grade seven science. Additionally, a strong positive correlation ($r = 0.787$) was observed between students' attitudes towards ICT tools and their test scores. Based on these findings, this study recommends that teachers integrate ICT tools into their science instructions. The implementation of various ICT tools in the classroom can provide students with a comprehensive and engaging learning experience, enabling them to better comprehend and apply key scientific concepts.

1. Introduction
Students today live in a world of ICT and they are connected through computers, the internet, radio, television, and smartphones (Kinley *et al*., 2013) [10]. Students in Bhutan are also exposed to ICT like any other student in the world. ICT is changing the way the world works and will continue to evolve in the coming days. Therefore, Bhutanese should be ready to face the new revolution in science and technology (Bhutan, 2004) [4]. According to REC (2017) ICT makes information and knowledge easily accessible to everyone. It is high time that there should be a change in the pedagogy used by teachers in their daily teaching to ensure students are ready to compete in the digital world. Moreover, there is a growing demand for teaching and learning combined with technology in the 21st century.
The sampling school was educating 278 students from various family backgrounds while conducting this research. Though the school is located partially in a semi-urban area, it has all the ICT facilities and internet connections like any other school in Bhutan. However, most of the students have not been exposed to such facilities before and they find it difficult to use for academic purposes. Moreover, teachers also find it difficult to incorporate ICT in their lesson plans because they are also in the process of transforming. Additionally, it was found difficult for class seven students to understand the scientific concepts in science. The teacher uses all the teaching strategies and pedagogies to explain the conceptual meaning but they still do not understand theories and working. According to Ratheeswari (2018) [16] ICT gives opportunities to learn and apply twenty-first-

century skills to the students. Similarly, Ugwu and Nnaekwe (2019) [23] asserted that the integration of ICT concepts and applications in school education gives teachers and students the flexibility to learn and teach based on individual needs. However, there are very minimal studies conducted in the Bhutanese context.

1.1. Effectiveness of ICT tools in teaching

Ojo and Adu (2018) [14] conducted research in Africa with 450 mathematics students and found that ICT enhances their learning and conceptual comprehension. Similarly, the study conducted by Nawzad *et al*. (2018) [12] in one of the schools in Iraq with 50 students from grades three and five confirmed that technology helped students complete their homework, enhanced their enthusiasm in the learning process, and boosted their accomplishment scores in science subjects. Likewise, it was found that ICT has a positive effect on PISA scores in science in the Spanish Autonomous Communities. Furthermore, it was concluded that students find the Internet very useful and accessible at Ekiti State University, Nigeria (Adesoji, 2020) [2]. Furthermore, a study conducted by Odell *et al*. (2020) [13] found that students who were more comfortable with ICT facilities performed better in science. The finding indicates knowing how to use the ICT tools in the right way has a positive impact on students' learning.

The studies conducted by scholars revealed ICT not only helps comprehend abstract concepts in science but also helps in literacy comprehension. The case study conducted by Bakeer and Aida (2018) [3] with 72 undergraduate students found that the integration of ICTs and social media had a positive effect on developing students' writing skills in English. Likewise, the study conducted by Das (2019b) [7] shows that ICT integration in mathematics education has a positive impact on both the teaching and learning process. However, a study conducted by in Spanish Autonomous Community found ICT does not have positive effects on PISA scores in mathematics. The contradictory findings from the past literature provide the platform for the researchers to validate the truth.

Smartphones have become a learning tool with great potential in both classrooms and outdoor learning. The review done by Ramos-Pardo (2022) [19] found that smartphones have a positive impact on students even though there are some drawbacks in other areas. Likewise, the research conducted by Chivige (2020) [5] suggested that teachers can use PowerPoint's bulleted list feature to arrange their notes for the classroom while teaching with a help of a multimedia projector. It was also found that when teaching materials are well-organized, students are able to take better notes. Moreover, PowerPoint presentation helps teachers quickly reiterate a concept to the students.

1.2. The attitude of students toward ICT tools

Das (2019a) [6] found that ICT has the potential to create a conducive learning environment and help learners develop creative thinking and self-confidence. Similarly, the research conducted by Torres-Gastelu and Kiss (2016) [17] found that Hungarian and Mexican students have a positive attitude toward ICT. The employment of ICT as a constant tool for learning and social communication was well-regarded in the eyes of students. However, a study conducted by Heflin *et al*.

(2017) [9] found that students who produce their written responses on a computer or paper appear more likely to exhibit profound critical thinking than students who compose their written responses by shorthand typing on a mobile device. These findings collectively imply that teachers need to use a wide range of resources to build engaging learning environments, but need to understand the strengths and weaknesses of the resources used.

1.3 Importance of ICT in teaching

The uses of ICT in education are widespread and are continually growing worldwide. According to Yadav and Mehta (2014) [18] ICT is evolving very fast and it should be incorporated into educational activities. The researchers also claimed that one cannot neglect the internet as learning activities that were formerly manual source-centered should now be open-source-centered. Likewise, ICT has the potential to assist Bhutan to overcome its geographic limitations (Bhutan, 2004) [4]. Park and Weng (2020) [15] stated that ICT empowers learning and improves academic achievements. Furthermore, Lawrence (2022) [11] revealed that ICT provides a variety of content that helps learners concentrate, better understand, and long retention of information which is not possible otherwise.

According to Abdullahi (2013) [1] one of the benefits of ICT is that it helps students develop their intellectual abilities by encouraging higher-order thinking, problem-solving, increased communication, and a thorough comprehension of the teaching materials and concepts. ICT has a significant positive impact on society. Moreover, studies conducted by Lawrence (2022) [11]; Susanna (2022) [22]; Park and Weng (2020) [15] found that the use of ICT in teaching has a lot of advantages. Some of the advantages of using ICT are;

- ICT removes problems concerning space and time
- ICT helps to communicate anywhere and anytime
- ICT makes sharing knowledge easier for the learners
- ICT makes earning interactive and joyful
- ICT opens windows for innovation
- ICT brings excitement and motivates learning
- ICT improves the quality of instruction
- ICT increases the quality of learning

2. Methodology

The quantitative method was used to carry out this research. The tools used were the achievement tests and the survey questionnaires. The 27 purposefully selected participants attempted the test and survey questionnaires after the intervention. For achievement tests, a comparative analysis was done using one sample t-test. Similarly, the mean and SD were computed for the survey questionnaires, and the summary of findings was presented as a table.

An overhead projector was used to teach the scientific concepts of mixture in the class. Simulation, images, and videos were shown to the students to clarify the conceptual meaning. Students were also made to explore the topics on the internet and clarify the conceptual meaning in the school information and technology laboratory. Moreover, students were made to use their relative's smartphoe to browse the internet and learn scientific concepts at home during the weekend. They were provided with relevant websites to be browsed at home.

3. Results and Findings
3.1 Effectiveness of ICT Tools in Teaching Grade Seven Science
Data analysis was done purely based on the information collected from the achievement test, and the survey questionnaires. The first objective of the study was to investigate the effectiveness of ICT tools in teaching mixture in grade seven science. Descriptive analysis was conducted to compare the means of the test value and test scores. Additionally, inferential analysis was conducted to determine the presence of a significant mean difference between the test value and test scores of the grade seven students. Statistical measures, including mean, standard deviation, t-value, df-value, p-value, and Cohen's d, were utilized during the data analysis process.
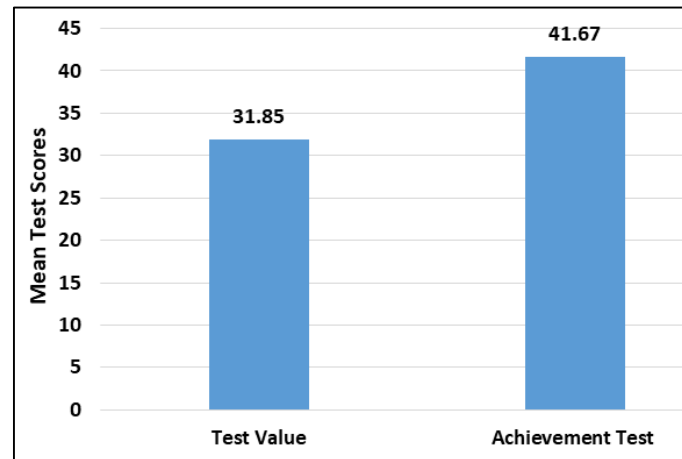

Fig 1: Mean Scores for Test-value and Achievement test

Based on the information presented in Figure 1, it is evident that there is a noticeable improvement in the mean test scores between the test value and the achievement test scores. This observation indicates that the utilization of ICT tools has a significant influence on the academic performance of grade seven students in the field of science.

Table 1: One-Sample Test

	Test Value = 31.85				
	Mean Difference	**t**	**df**	**Sig. (2-tailed)**	**Cohen's d**
Achievement test	9.817	4.226	26	.000	.813

Additionally, an inferential statistical test was conducted to determine the statistical significance of these findings and draw more robust conclusions. One sample t-test was conducted between a known mean test value and a test score of the students with a 95% confidence level and it was found that there was a significant mean difference between the tests; t (26) = 4.226, $p < 0.05$). Further, Cohen's d was calculated to assess the magnitude of the difference between the tests of the grade seven students. The calculated value of Cohen's d was .813 indicating a large effect size.

3.2. Attitude of Grade Seven Students Toward ICT Tools.
Another objective of the study was to determine grade seven students' attitudes toward ICT tools while teaching science. Survey questionnaires were used to test the attitude of students toward ICT in teaching and learning. Students' responses to survey questionnaires are given below in Table 3.

Table 2: Students' attitudes toward ICT tools

Sl. No	Statements	N	Mean	SD	Attitude description
1	Uses of ICT boost my interest in learning	27	4.22	.801	Very Good
2	I never get bored and fall asleep when a teacher uses ICT.	27	4.22	.801	Very Good
3	ICT makes the course content lively.	27	3.81	.834	Good
4	I understand more when the teacher uses a projector in teaching.	27	4.37	.492	Very Good
5	I can reason better from the topic taught with the help of ICT.	27	3.70	.993	Good
6	I can reflect more on what I have learned when a teacher uses ICT.	27	4.19	.622	Good
7	Uses of the Internet help in Scientific learning	27	4.30	.823	Very Good
8	I think information from the internet is more relevant than the book.	27	3.93	1.035	Good
9	I think videos and pictures from the internet clarify scientific concepts.	27	4.33	.480	Very Good
10	Smartphones help to clarify doubts at home	27	4.19	.921	Good
	Overall mean and SD	27	4.13	.269	Good

Note*:*1.0-1.8 = Very Poor, 1.8-2.6 = Poor, 2.6-3.4 =Average, 3.4-4.2=Good, 4.2-5.0 = Very Good)

Table 3 indicates that, on average, the participants reported positive attitudes toward ICT tools while teaching science. The mean scores for each statement ranged from 3.70 (*SD*=.993) to 4.33 on a scale of 1 to 5, with a higher score indicating a more positive attitude. The overall mean score for all statements was 4.13 (SD=.269), suggesting a generally

positive attitude towards ICT tools while learning science.

Table 3: Correlation between attitude and post-test scores

	N	Pearson Correlation	Sig. (2-tailed)
Attitude and Test	27	.787	.000

A Pearson Correlation was used to examine the relationship between the attitude of participants towards science when taught using the ICT tools and the achievement test scores of the participants. There was a strong positive correlation between the two variables and it was found statistically significant (r (27) = .787, $p <$ .05).

Table 4: Regression Analysis between attitude and post-test scores of the students

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.787[a]	.619	.603	7.600

a. Predictors: (Constant), Total Attitude

Table 5: ANOVAa

ANOVA[a]						
	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2343.387	1	2343.387	40.568	.000[b]
	Residual	1444.113	25	57.765		
	Total	3787.500	26			

a. Dependent Variable: Achievement Test
b. Predictors: (Constant), Total Attitude

Table 6: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-103.544	22.845		-4.532	.000
	Total Attitude	3.519	.553	.787	6.369	.000

a. Dependent Variable: achievement-Test

A simple linear regression was calculated to predict the post-test scores of the participants based on the attitude of participants towards science when taught using the ICT tools, b = .787, t (27) = -4.532, $p <$ .05. A significant regression equation was found F (1,25) = 40.568, $p <$ .05, with an R^2 of .619. This indicates the variation in test scores is 61.9% because of the attitude of the students toward the ICT tools.

4. Discussion

One of the objectives of the study was to investigate the effectiveness of ICT tools in teaching a mixture of grade seven science. Descriptive analysis revealed that there was a noticeable improvement in the mean test scores between the test value and the achievement test scores. Additionally, one sample t-test revealed that there was a significant mean difference between the tests with ($p <$ 0.05). Further, the calculated value of Cohen's d was .813 indicating a large effect size. The results indicate that the utilization of ICT tools such as projectors, smartphones, and the internet has a significant influence on the academic performance of grade seven students in the field of science. The current research findings align with the study conducted by Park and Weng (2020) [15], who found that the use of ICT tools enhances learning and enhances academic performance. Similarly, Yadav and Mehta (2014) [18] also noted that the internet plays a significant role in facilitating student learning and cannot be disregarded in their lives. Furthermore, Ramos-Pardo's review (2022) [19] concluded that smartphones have a beneficial effect on students' learning. The findings of this research and previous literature consistently support the notion that ICT tools are essential in today's educational environment. As a result, educators should integrate ICT tools into their teaching methods to augment student learning. Additionally, the findings suggest that utilizing smartphones at home to access academic information positively influences students' learning outcomes. Consequently, it is crucial to allow students to access information from their smartphones at home as well.

Another objective of the study was to determine grade seven students' attitudes toward ICT tools while teaching science. The findings indicated that, generally sample students have a positive attitude towards ICT tools while learning science in grade seven. The responses given by the respondents indicated that ICT plays a vital role in students learning and they have a positive attitude towards ICT Tools. The research findings are parallel with literature by Lawrence (2022) [11]; Susanna (2022) [22]; Park & Weng (2020) [15]; and Abdullahi (2013) [1] also reported that the use of ICT in teaching brings interaction, motivation, excitement, and increased quality of student learning indicating they positive attitudes of the students towards the ICT tools. Likewise, the findings also indicated that the respondents understand the concepts well when the teacher uses a projector in teaching and the respondents can reflect well on what they have learned when a teacher uses ICT which aligned with past research. The respondents also felt that they were able to reason better from the topic taught with the help of ICT. The past literature also stated that ICT provides variety in the presentation of content which helps learners concentrate, better understand, and long retention of information which is not possible otherwise. The maximum of the respondents think videos and pictures from the internet help clarify scientific concepts. The literature by

Yadav & Mehta (2014) [18] asserted that ICT is evolving very fast and can not be neglected in educational activities even though students may get engaged in online games. Generally, the findings indicated that the Internet helps in scientific learning, while some respondents think that the information from the book is more relevant than the Internet. Literature also states that ICT offers enormous benefits to all but there can be some limitations as well (Ramos-Pardo, 2022) [19].

A Pearson Correlation was used to examine the relationship between the attitude of participants towards science when taught using the ICT tools and the achievement test scores of the participants. The result revealed a strong positive correlation between the two variables and it was found statistically significant (r (27) = .787, $p<$ .05). Further, a simple linear regression indicated the variation in test scores was 61.9% because the attitude of the students toward the ICT Tools. The research findings are consistent with the study conducted by Lawrence (2022) [11]; Susanna (2022) [22]; Park & Weng (2020) [15]; and Abdullahi (2013) [1] who also noticed that the learners have positive attitudes towards ICT in teaching and increased quality of student learning and achievements. This indicates that ICT tools are indispensable instruments for teaching, as they facilitate students' understanding of concepts. The consistent findings from this study and previous research highlight the crucial role of ICT tools in teaching, regardless of geographical region or curriculum type.

5. Conclusion
Such research not only helps teachers to learn and develop professionally but also enables them to implement the research findings in their future practices. The findings of the study revealed that students exhibit improved learning outcomes when teachers utilize ICT tools in their teaching, underscoring the crucial role of ICT tools in the teaching and learning process. Additionally, the study revealed that students hold a positive attitude towards ICT tools. Moreover, the results highlight a strong positive correlation between participants' attitudes towards ICT tools and their achievement test scores. Furthermore, the study indicates that 61.9% of the variation in test scores can be attributed to students' attitudes toward ICT tools.

The researchers strongly recommend that teachers incorporate the use of ICT tools in their teaching practices. Among the gadgets examined, projectors, smartphones, and the internet were identified as having a positive impact on students' learning outcomes. Furthermore, the researchers suggest that future studies focus on expanding the sample size and exploring additional subjects to further enhance the findings.

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