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Research Article

Impact of ICT integration on Teaching and Learning

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Abstract

In the 21st century, technology is indispensable and serves as a catalyst for globalizations, intellectual labour, and entrepreneurship. In the 21st century, technology is essential and acts as a catalyst for globalization, intellectual labour, and entrepreneurship. Bhutan has significantly prioritized the digitalization of the nation as it continues to evolve. The incorporation of technology into Bhutan's educational framework has grown progressively significant. This study assesses the status of technology integration and teaching practices and their impact on school management. It evaluates teachers' general competency in ICT knowledge and their perspectives on the usefulness of integrating it into the teaching-learning environment. The effectiveness of the CodeMonkey programme was examined at Lobesa Lower Secondary School (LLSS) in Punakha District, Bhutan after it was introduced as a mandatory subject from pre-primary to eighth grade in 2020. A mixed-methods approach was used, combining qualitative and quantitative data. The study included teachers and students from grades 6 to 8 at LLSS, with participants selected through simple random sampling at a 50% sampling intensity, resulting in 33 teachers and 165 students. Structured questionnaires were distributed online via Google Forms, and data analysis was conducted using Microsoft Excel functions. Qualitative data was analyzed using Creswell's six-step method. Findings indicate that teachers at LLSS are comfortable integrating ICT into teaching practices, which has positively influenced student engagement; however, they lack ICT-based professional development. Additionally, the CodeMonkey programme was beneficial for younger students. The study recommends continuing the CodeMonkey programme for lower-grade students and adapting programming classes for higher grades to match the student's learning abilities. We also advise teachers to enhance their ICT proficiency through ICT-based professional development.

Keywords: Technology; ICT; Teaching; Learning; School

Introduction/Background

In the 21st century, technology is essential and acts as a catalyst for globalization, intellectual labor, and entrepreneurship. Technology has become indispensable in the 21st century and serves as a catalyst for globalization, intellectual labor, and entrepreneurship. As it continues to evolve, Bhutan has greatly emphasized digitalizing the country. The integration of technology into Bhutan's education system has become increasingly important [1]. Recognizing the role of Information and Communication Technology (ICT) in education, the Ministry of Education drafted its Education ICT Master Plan in 2014 [2] . Enabling policies, plans, and strategies have been developed to promote digital literacy in education, including a specific ICT Education Master Plan [3,4].

Through the Education ICT Master Plan, the Ministry of Education emphasized integrating technology-based teaching and learning into school curricula. Incorporating technology into teaching methods has significantly advanced, focusing on bridging the digital divide and improving educational outcomes. Teachers now plan their lessons using ICT, incorporating student activities that teach abstract concepts through various pedagogical techniques, which enhance students' understanding. In 2020, ICT was made a mandatory subject for pre-primary to eighth grades nationwide. This initiative included the introduction of a popular digital platform called the CodeMonkey program, designed to teach coding as part of the Bhutanese education curriculum. Additionally, the initiative seeks to enhance digital literacy and introduce coding to school students. CodeMonkey aims to develop students' coding and computational thinking skills in an interactive, game-based format [5].

The impact of the ICT integration on students' learning skills can be significant in several ways. By using these skills, students develop essential skills that are in high demand in the job market, such as programming, problem-solving, and digital literacy. These foundational coding skills can spark an interest in technology-related fields and prepare students for the future.

Overall, research consistently identifies the positive impact of digital technologies on learning [6]. While past research has focused on the overall integration of technology into teaching practices and its positive effects on educational outcomes, no impact study has been conducted on the CodeMonkey program introduced in 2020 in Bhutan. As a result, it remains unclear whether this program has provided sufficient benefits or if it warrants further continuation within the education system.

Objectives

The main objective of this study was to investigate:

- Impact of ICT integration to teachers and students' learning
- Effect of technology integration into traditional teaching practices *vis á vis* administrative processes in Lobesa Lower Secondary School (LLSS).

Research questions

Based on the objectives the following were asked:

- What is the status of technology literacy of teachers in LLSS and their perception of technology integration in teaching practices?
- How does technology integration influence teacher-student interactions and school management?
- Attitude towards ICT integration by students from class six to eight

Literature Review

Integrating technology into traditional teaching methods has had significant implications for school management and educational outcomes. This transformation has changed how knowledge is delivered and managed in educational institutions. The use of technologies such as interactive whiteboards, learning management systems, virtual classrooms, and digital resources has shifted the focus from teacher-centered to student-centered approaches. Research suggests that technological tools can enhance students' learning abilities and problem-solving skills, fostering a more engaging and dynamic classroom environment compared to static, lecture-based teaching [7,8].

However, the effective integration of technology requires informed leadership from school administrators, who play a crucial role in supporting teachers and facilitating necessary changes in curriculum and pedagogy [9,10]. Principals who exhibit strong technological leadership can positively influence teachers' attitudes toward the use of educational technologies, which is essential for successful integration [11].

Another key factor highlighted in literature is the importance of teacher preparation for technology integration. Effective teacher education programs must embed technology training within their curricula to ensure that future educators are equipped to use these tools proficiently [12].Teachers may face a steep learning curve when adapting to new technologies, and some may resist the change due to unfamiliarity. Without proper training and professional development, the potential benefits of technology integration may not be fully realized [13]. Therefore, school management must prioritize professional development initiatives aimed at improving teachers' technological competencies.

In addition to its impact on classroom practices, technology integration also influences school management. The use of information and communication technologies (ICT) can streamline administrative processes, improve communication, and enhance resource management within schools [14]. These authors fur-

ther argue that integrating technology into school management is crucial for improving operational efficiency and supporting educational reforms. This integration leads to more effective decision-making processes and better resource allocation, ultimately benefiting the entire school community.

The integration of technology into traditional teaching methods has far-reaching implications for both educational practices and school management. It requires a collaborative effort among educators, administrators, and policymakers to create an environment conducive to effective technology use. By prioritizing teacher training, fostering strong leadership, and embracing innovative management practices, schools can better navigate the challenges and opportunities presented by technology integration.

Research process

Following the approval of the action research proposal by the Human Resource Division under the Ministry of Education and Skills Development, the researcher developed the necessary tools and carried out the study over one month.

Research Methodology

This research study utilized a mixed-method approach, combining both qualitative and quantitative data. The qualitative component explores perspectives on the integration of ICT in teaching practices, while the quantitative component, based on closed-ended survey questionnaires, describes the frequency distribution of responses.

Population and sampling

The total population consisted of 198 respondents, comprised of teachers (n = 29), administrative staff (n = 4), and student participants from grades sixth, seventh, and eighth (n = 165) from Lobesa Lower Secondary School in Punakha District, Bhutan. A simple random sampling method was applied to select the respondents among the teachers and administrative staff, while cluster random sampling was used to select students from grades six to eight, with a sampling intensity of 50% across all strata.

To avoid bias and ensure diverse perspectives, respondents were further segregated by gender. The following formula was used to select female and male respondents by assigning a 50% proportionate ratio:

= INDEX(male/female/administrator/teachers/students,n(intensity))in Microsoft Excel.

Research instruments

Structured survey questionnaires were distributed to all selected respondents using an online Google Form. The questions aimed to collect insights from teachers, school administrative staff, and students about their experiences, attitudes, and perceptions of technology integration in education, as well as the challenges they face and their suggestions for future actions. Since the study is designed to obtain responses from three different categories of respondents, two separate questionnaires were developed: one combined questionnaire with 39 items for teachers and administrators and the other for students with 23 items. Both the questionnaires consisted of 4 sections. Section A is about the demographic background of the respondents and includes age, gender, and the number of work experiences of teachers and administrative staff, while students were asked to fill out only gender and age. The other three sections of the questionnaires focus more on perceptions, challenges, and the way forward of ICT integration in teaching and learning. The questionnaire items were designed and developed by the researcher to provide answers to research questions. Furthermore, direct interviews and classroom observations were conducted to gain a deeper understanding of real-world situations.

Data analysis

In this study, the researcher followed Cresswell's (2013) six-step process for qualitative data analysis. All data collected from respondents via Google Forms was compiled and analyzed using Microsoft Excel's functions. Open-ended responses were examined by identifying themes and patterns that aligned with the research objectives [15], as cited in [16]. Additionally, respondents rated each thematic area using a 5-point Likert scale, ranging from 'I feel very uncomfortable' (1) to 'I feel very comfortable' (5). These ratings were presented as percentages and summarized to address the research questions. Similarly, responses from students were summarized and analyzed separately to evaluate the usefulness of ICT, specifically focusing on CodeMonkey programs. Regression analysis was carried out to predict significant relationships to the dependent variable (CodeMonkey).

Findings

The results of this study are presented in the order of the research questions. For clarity in data interpretation, teachers and adminisrative staff are grouped under the category "teachers," while students' responses are analyzed separately.

RQ1: The current technology literacy of teachers and their perceived usefulness

Out of the 198 respondents, 33 were teachers, and based on gender 17 were female and 16 male. The questions asked of respondents covered the number of teaching services, comfort level with technology integration, benefits of using technology in the classroom, support for decision-making at school, and the impact of technology on student engagement.

The responses indicate that most teacher respondents had over 5 years of teaching experience (n = 12) or more than 10 years (n = 19), while only a few had less than 1 year of experience. The respondents ranged in age from 21 to 45 years, with two respondents over 50 years old. All respondents had access to basic ICT tools, such as laptops and tablets. Approximately 57% (n = 19) of respondents reported "feeling very comfortable" using ICT technology. Additionally, 52% (n = 17) indicated that technology had increased their access to teaching resources, 12% (n = 4) found it enhanced collaboration, 9% (n = 3) felt it improved tracking of student progress, and 24% (n = 8) believed it had boosted student engagement. About 4% (n = 4) noted that technology provided personalized learning opportunities.

The results show that, demographically, teachers at Lobesa Lower Secondary School are within a more productive age range (21 to 50 years) and possess at least basic technological skills to use and apply in their teaching practices. However, they view the use of technology primarily as a catalyst for enhancing classroom interactions and tracking students' progress.

RQ2: Influence of Technology on teacher-student Interactions and School Management

Nearly all teacher participants believed that ICT integration in teaching practices significantly enhances student engagement.

Student engagement

Over 53% (n = 17) of teachers reported that ICT integration leads to better student engagement in the classroom, while 47% (n = 15) observed a slight increase in student engagement due to technology use.

Improved communication

ICT integration has also facilitated better communication among teachers, students, and administrative staff. This includes improvements in:

- Maintaining attendance records
- Record keeping
- Conducting online assessments
- Lesson planning
- Decision-making processes

To find out whether the duration (in hours) a teacher spent on teaching the code monkey is significantly impacting the engagement of student with ICT was determined and analyzed.

The logistic regression model predicted this independent variable as statistically significant at a p-value of 0.08 (at 5%). However, the likelihood of duration teachers spend on teaching ICT and enhancing student engagement is minimal at just 1%. Moreover, the integration of ICT technology in the school curriculum has been initiated and as with other subjects duration allotted for ICT classes is limited to a few hours on a weekly basis.

The various technological supports employed for making the decisions related to school management were assessed to predict the likelihood of influencing student engagement. The result of a logistic regression illustrated the independent variable as statistically significant with a p-value of 0.03 and a likelihood of 45%. However, the model predicted a negative correlation, indicating reverse influences on student engagement. The possible reason for this could be that the decision made may not be to influencing student engagement directly as expected. Also, the traditional method of teaching versus advanced driven by technological integration is yet to progress.

Table 1: Regression Analysis for the impact of technology integration on student engagement.

Dependent variable (DV): Impact of technology integration on student engagement								
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Independent Variables (IVs)	0.0151	0.4424	0.0341	0.9731	-0.9078	0.9380	-0.9078	0.9380
Training on Code Monkey	-0.5817	0.4070	-1.4294	0.1683	-1.4306	0.2672	-1.4306	0.2672
Hours spent on teaching code monkey	0.0095	0.0053	1.8019	0.0867	-0.0015	0.0205	-0.0015	0.0205
Adequecy of training	-0.0403	0.3100	-0.1300	0.8978	-0.6870	0.6063	-0.6870	0.6063
Interaction enhanced after code monkey integration	0.0067	0.2127	0.0315	0.9752	-0.4370	0.4504	-0.4370	0.4504
Affect of technology on management	-0.0265	0.2385	-0.1112	0.9126	-0.5240	0.4709	-0.5240	0.4709
Technology support in decision-making	-0.4548	0.2068	-2.1990	0.0398	-0.8862	-0.0234	-0.8862	-0.0234
Impact on quality of education	0.2105	0.2397	0.8782	0.3903	-0.2895	0.7106	-0.2895	0.7106
School support system	0.4182	0.2179	1.9194	0.0693	-0.0363	0.8727	-0.0363	0.8727
Technology integration necessitated	0.3564	0.4307	0.8275	0.4177	-0.5420	1.2547	-0.5420	1.2547
Training received useful for your profession	-0.2197	0.3640	-0.6036	0.5529	-0.9790	0.5395	-0.9790	0.5395
Effectiveness of training	-0.0401	0.2914	-0.1377	0.8918	-0.6480	0.5678	-0.6480	0.5678
Availability of ICT resources	-0.0845	0.2177	-0.3883	0.7019	-0.5386	0.3695	-0.5386	0.3695

The introduction of ICT programs in the school curriculum is accompanied by both software and hardware components making it available to the students. Based on the current support system that the school is able to provide the integration of ICT is assessed. The question was framed to get a view of a respondent in Yes (value assigned 1) if it was felt important to have a school support system and have been receiving required support. However, if the answer to this question is No (value assigned 0) it means no support is received from the school to realize the engagement of students in ICT technology. The logistic regression model predicted this independent variable as statistically significant with a p-value of 0.06 at 5%. The model indicates the likelihood of enhancing the students' engagement in ICT by 41%. As expected the school support system is vital for the successful integration of ICT to enhance student engagement.

RQ3: Difference in attitude towards the CodeMonkey program among different grades of students

The main objective of this study was to evaluate the effectiveness of the CodeMonkey program as a mandatory subject. Furthermore, the CodeMonkey program primarily targets students in grades PP to 8. Therefore, the analysis focused on assessing the program's usefulness to students. A regression analysis was conducted with the usefulness of the CodeMonkey program as the dependent variable (DV) and multiple independent variables (IVs) to test the model's significance. As shown in Table 2, the R^2 value of 0.5076 indicates that the model has moderate explanatory power. The Adjusted R^2 suggests that adding additional predictors does not substantially improve the model. Furthermore, the Analysis of Variance (ANOVA) for the regression model, with a p-value of 2.38E-19 (Table 3), shows that the model is statistically significant, indicating that at least one predictor contributes to explaining the variance in the dependent variable.

Table 2: Regression Statistics.

Regression Statistics	
Multiple R	0.71243225
R Square	0.50755971
Adjusted R Square	0.475583068
Standard Error	0.333816945
Observations	165

Table 3: Analysis of Variance (ANOVA) for Regression Model.

ANOVA	df	SS	MS	F	Significance F
Regression	10	17.68768687	1.768769	15.87282702	2.37752E-19
Residual	154	17.16079798	0.111434		
Total	164	34.84848485			

A regression analysis was conducted to examine the usefulness of CodeMonkey (DV) in relation to ten independent variables, including grade level, exposure, engagement level, attitude toward ICT, comfort with group collaboration, use of ICT in group work, satisfaction with CodeMonkey, and availability of ICT resources. The results showed that only three independent variables—grade level (6, 7, and 8), satisfaction level, and availability of ICT resources—were highly significant (Table 4).

The independent variable "Grade" interpreted as the number of years a student has spent learning in school, is statistically significant, with a p-value of 0.0148 at the 5% level. The findings also indicate that the CodeMonkey program introduced in the school is beneficial for lower-grade students, as evidenced by an inverse relationship, reflected in a coefficient value of -11%.

Table 4: Regression Analysis for the usefulness of CodeMonkey.

Dependent variable	Usefulness of Code Monkey	
Significant Independent variable	**P-value**	**Coefficient**
Grade (6,7&8)	0.0454 at 5%	11%
Satisfication level on code monkey	0E+00	53%
ICT resources availability	0.00398 at 1%	19%

At LLSS, the CodeMonkey program was implemented for students from PP to grade 8. The study examined student satisfaction, gathering pertinent information. The logistic regression model indicated that student satisfaction with CodeMonkey was statistically significant, with a p-value of 0.0000 at the 1% level. The integration of the CodeMonkey program appears to enhance student satisfaction, with a coefficient of 53%.

Currently, LLSS has more than 80 computers available for 900 students. This ratio suggests a shortage of computers, highlighting inadequacies in ICT resources for students and overall management of the ICT program. According to the logistic regression model, the availability of ICT resources is statistically significant, with a p-value of 0.00398 at the 1% level. Improving ICT facilities in the school is likely to support the objectives of the CodeMonkey program.

Discussion and Conclusion

The results of this study indicate that teachers at Lobesa Lower Secondary School possess basic technological skills, making technology-based teaching and learning more effective compared to traditional methods [17]. Although ICT facilities are limited in classrooms, teachers feel comfortable using ICT tools as these provide access to a wider range of teaching resources and make learning more engaging. The findings also show that only a few teachers have received training in ICT-related programs. For those untrained, other teachers report challenges in effectively utilizing ICT both inside and outside the classroom. Ertmer., *et al*. [18] assert that successful technology integration relies on teachers' current knowledge, skills, attitudes, and beliefs about technology. This highlights a strong potential for improvement in technology integration through rigorous professional development focused on ICT skills. Tshering [19] emphasized the need for professional development in ICT to "enhance teaching skills, which is crucial in the 21st century". Ertmer and Ottenbreit-Leftwich [20] suggest that effective technology integration requires proper training and professional development for teachers. Additionally, the study reveals that ICT use in classrooms has boosted student engagement, fostering better coordination and collaboration between teachers and students.

The study also found that teachers spend limited time on ICT classes—typically only once a week, with a maximum of 80 minutes (equivalent to one double lesson). This limited time may be due to the scarcity of ICT resources for approximately 900 students. Nonetheless, the study suggests that ICT has positively impacted students' learning skills, and an increase in time allocation for ICT classes could be beneficial. Specifically, the integration of the CodeMonkey program has positively impacted students, as shown by their satisfaction level, with a coefficient of 53%. This suggests that student satisfaction strongly predicts perceived usefulness; the more satisfied students are with CodeMonkey, the more useful they find it. However, Code Monkey's usefulness appears more relevant to lower-grade students (younger age groups) due to its vibrant colors, simple interfaces, and beginner-level coding content [21].

Limitations of the Study and Future Actions

This study was conducted over a short period and at a single school level. Only 50% of the teachers were selected to participate, which may limit the generalizability of their perspectives. Similarly, the sample students were chosen from grades 6, 7, and 8, while CodeMonkey and ICT programs have been introduced as early as pre-primary (PP). To enhance the validity of these findings, similar studies should be conducted in other schools with a larger number of participants.

Recommendations

The study found that technology integration positively impacted the teaching-learning environment, particularly in enhancing student engagement at Lobesa Lower Secondary School (LLSS) and supported decision-making for school management. Based on the findings, the following recommendations are proposed:

- **Enhanced ICT Facilities for Younger Learners:** ICT should be an integral part of teaching methods, especially for younger students. School management should consider providing improved ICT facilities with reliable internet connection to make learning more impactful.
- **Continuation and Expansion of the CodeMonkey Program:** The CodeMonkey program should continue, with a particular emphasis on lower-grade students. Additionally, the frequency of engagement should be increased from once a week to two or three times a week.
- **Professional Development in ICT for Teachers and Administrative Staff:** Teachers and administrative staff should be given opportunities for professional development programs in ICT to enhance their technological skills, which will benefit the overall management of the school.

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