Academia Journal of Humanities & Social Sciences
Volume 2, April 2025
[Peer-Reviewed and Indexed in NepJOL]
p-ISSN 3021-9841; e-ISSN 3021-985X
http://myagdicampus.edu.np/academia/
MMC, Beni

Research Article/ Sustainable Higher Education

Integrating ICT and Generative AI in Classrooms for Sustainable Development: The Case of Schools in Nepal

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Article History:
Submitted 22 December 2024
Reviewed 26 February 2025
Revised 28 February 2025
Accepted 25 March 2025

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Article DOI:
https://doi.org/10.3126/ajhss.v2i1.77159

ABSTRACT

This study aims to explore how ICT and AI are integrated into the classroom, emphasizing their impacts on teaching and learning. At a time when global education is extensively using digital tools, this study intends to discover how ICT and AI enhance better learning and teaching, ensuring digital literacy and reducing learning inequalities. ICT and AI provide quality education with personalized learning experiences enabling the real time assessment of students and empowering the marginalized communities to get an access to the mainstream education system. Additionally, the integration of ICT and AI helps reduce the use of papers in the classrooms and replace them with the digital learning materials. This increases energy-efficient, environmentally friendly school management ensuring sustainable development. The research design encompasses a mixed-methods approach, where the data have been collected through the questionnaires and interviews with the participation of selected teachers, students, and administrators from different schools in Pokhara Metropolitan City in Nepal. The preliminary findings showed that despite a high degree of interest in the adoption of ICT and AI, a bottleneck exists due to the inadequate infrastructural capacity, lack of teacher training for such technologies, and limited availability of advanced technology. The schools that have integrated the ICT tools such as interactive whiteboards and online learning platforms into the classrooms demonstrated improved engagement and academic outcomes among students. AI applications, like the personalized learning systems, would offer the customized learning experiences, especially in mathematics and languages. The study also demonstrated that these technologies need a policy enabling a

framework, along with a cooperation among the government, educational institutions, and the private sector, which can surmount the barriers for an effective integration. The study will, therefore, be of great use to educators, policymakers, and other stakeholders with recommendations on how best the schools can make use of technology and at the same time advance equal opportunities for quality education. Further research is recommended to explore the long-term impact of these technologies on the student learning outcomes.

KEYWORDS: Information Communication and Technology (ICT), Generative AI, online learning platforms, AI tools

INTRODUCTION

Information Communication Technology (ICT) is a modern conception in the field of pedagogy. It refers to the use of computers and other digital devices to store, retrieve, transmit, and manipulate information. In essence, it encompasses the tools and technologies that enable us to communicate, access information, and perform tasks more efficiently and effectively. Similarly, Artificial Intelligence (AI) is related to a machine learning with the human brain. Machine learning is a branch of AI that focused on building the computer systems that learn from the data. Machine learning, in specific, accounts for a huge portion of AI funding since it learns properly strong data from the diverse sources and gets the insights from the data to achieve the intelligent decisions dynamically. AI is the simulation of human intelligence processes by machines, especially the computer systems. The examples of AI applications include expert systems, natural language processing, speech recognition, and machine vision.

Russell and Norvig (2016) advocate for AI as it has various practical solutions from a smart personal assistance to the intelligent system that enables a facial recognition. For instance, it acknowledges that the intelligent machines are the best way to ensure humanity's long-term existence while Bostrom (2014) is skeptical doubting the unpredicted negative effects of uncontrollable AI. Nevertheless, AI includes machine learning, neural networks, and deep learning, but it has also become an umbrella term for many other data-related subjects.

Castro and New (2016) defined that AI is a field of computer science devoted to creating the computing machines and systems that perform the operations analogous to human learning and decision-making. Additionally, AI is a set of technologies that enable the computers to perform a variety of advanced functions, including the ability to see, understand, and translate spoken and written languages, analyze data, make recommendations, and many more.

Kukulska-Hulme (2021) analyzes the role of ICT and AI in supporting teachers' professional development and helping them stay updated with the latest teaching strategies. She asserts that AI-powered platforms can assist teachers by automating the administrative tasks, providing the insights into students' progress, and suggesting customized learning paths for students. This allows teachers to focus more on pedagogy and less on the tedious repetitive tasks.

Delalibera and Cavalcanti (2019) indicate that in the technology-oriented knowledge environment, the acquisition of new knowledge and skills warrants the introduction and continued use of technology-based learning and teaching tools including AI and ICT from a very early age. Inversely, therefore, it means that the teaching fraternity also needs to have the requisite training and preparation to be able to acclimatize to this new learning and teaching paradigm. The knowledge-based economic environment is the foremost factor that ups the demand for a technologically savvy

workforce, thus compelling the educational system to consider reinforcement of their teaching approaches with new technological capacities.

Pokhara is in the process of becoming a smart city despite its limited resources and population. The development of ICT and AI is slow due to the hilly setting, which imposes high transportation costs, and it requires creating an economy to spread the proper use of ICT. AI machines do not necessarily have to obtain intelligence by thinking like a human and it is important to make AI solve problems that can be solved by a human brain.

Dhital (2018) emphasizes that amidst the global technological advancements, ICT has emerged as a vital element of education systems worldwide. In Nepal, integrating ICT into the secondary education is critical not only for improving the quality of education but also for equipping students to thrive in a competitive global landscape. Although the Government of Nepal has introduced various programs to incorporate ICT into the educational curriculum, its implementation in the government secondary schools has been inconsistent.

In contrast, Hodges et al. (2020) emphasize the challenges that schools face when integrating ICT and AI, including the technical issues, lack of infrastructure, and resistance to change from educators and students. They suggest that to overcome these challenges, it is crucial to invest in the continuous training, provide the adequate resources, and foster a culture of innovation in schools.

According to Khanal and Shrestha (2020), Pokhara Metropolitan City, a major urban center in Nepal, provides a unique setting to explore these challenges and opportunities. Although the city has advanced its educational infrastructure, many government schools still struggle with insufficient technological resources, inadequate teacher training, and socio-economic disparities among students.

The use of ICT and AI tools such as interactive websites, e-mail, discussion boards, and redesign of educational infrastructure, teacher training, curriculum structures and materials, the classroom practices and modes of assessment at all levels are required. In the context of Nepal also, these measures are essential to transform all the challenges into opportunities and transform our traditional pedagogy to ICT friendly that fulfill the needs of the teachers, students, and even the educational institutions of contemporary information society.

The above discussion indicates that ICT and AI offer a transformative approach to education, enhancing understanding and skill development. While Nepal's government has made efforts to integrate ICT and AI into the school education curriculum, the challenges persist, particularly in schools in Pokhara Metropolitan City. Despite its progress, the transformation process faces the obstacles such as inadequate resources, teacher training, and socio-economic disparities. Overcoming these challenges is crucial for ensuring an equitable access to the quality ICT and AI education in Nepal.

RESEARCH METHODS

This study adopted a mixed-method research design to investigate the integration of ICT and AI in the classrooms of Pokhara Metropolitan City. It aims to understand the factors influencing the adoption and effectiveness of these technologies in the educational context and to examine the experiences and perceptions of educators and students. A purposive sampling method (Hernandez et al., 2024) was used to select the school's students as participants. The participants from the institution and community schools' 122 students, 10 teachers, and other stakeholders were the respondents of the study. In total, 132 samples were used. The data were collected through the interviews

and questionnaires. The semi-structured interviews were conducted with a selected group of teachers, school administrators, and students. The quantitative data were retrieved from the questionnaires, using descriptive statistics. Inferential statistics had been used to the identify relationships between the factors such as the school type and the frequency of technology usage (Schoenfeld et al., 2024). The thematic analysis of the qualitative data from the semi-structured interview was carried out with the use of Joffe's thematic analysis (2024). This approach identifies the recurrence of themes in the respondents' responses as a means to understand their experiences, perceptions, and challenges on ICT and AI in the classroom. The primary data were collected through the respondent survey and secondary data were collected through the published sources of Pokhara Metropolitan City official documents. The data collected were analyzed using the SPSS tool to compare and find the integration of ICT and AI. The variation in the collected data had been maintained to get the desired results. Informed consent was obtained from all the participants before the survey and interview. However, this study was limited to Pokhara Metropolitan City's prevalent status of the integration of ICT and AI in schools. The obstacles and challenges were faced by educators, policymakers, learners, and various stakeholders to effectively and efficiently support the integration of ICT and AI school education development.

Ethical considerations in the integration of ICT and AI in education are crucial to ensure the responsible use of technology. The key concerns include protecting the student privacy and data security, ensuring fairness and preventing bias in the AI systems, and obtaining informed consent from students and guardians. Transparency and accountability in the AI decision-making processes are essential, along with addressing the issues of access and equity to avoid exacerbating the digital divide. Moreover, it is important to preserve teacher and student autonomy, ensuring the AI complements rather than replacing the educators, and to monitor the long-term impacts on students' cognitive development and critical thinking skills.

RESULTS

The results mainly aimed to illustrate the integration of ICT and AI in schools of Pokhara Metropolitan City. An integration of ICT and AI tools is used by students and teachers, while facing the obstacles and challenges, and support of the different stakeholders.

Table 1

Gender of Participants

Gender	Frequency	Percent	Valid Percent
Male	67	50.8	50.8
Female	65	49.2	49.2
Total	132	100.0	100.0

The data presented in Table 1 reflects the gender distribution of participants in the study on integrating ICT and AI in schools in Pokhara Metropolitan City. A total of 132 participants were involved in the research, with 67 males (50.8%) and 65 females (49.2%). This indicates a nearly equal representation of both genders in the study. The balanced participation from both male and female respondents ensures that the findings reflect the diverse perspectives on the integration of ICT and AI tools in education. Such a gender-balanced approach is essential for understanding how both male and female

students and teachers interact with technology in the classroom setting, which can inform the future strategies for digital education in the region.

Table 2

Marital Status of Participants

Options	Frequency	Percent	Valid Percent
Married	13	9.8	9.8
Single	119	90.2	90.2
Total	132	100.0	100.0

Table 2 included 132 participants, with the majority being single (90.2%). A smaller proportion, 13 participants (9.8%), was married. This distribution reflects a significant preference for the respondents who are single, which may be indicative of the younger demographic of educators and students involved in the ICT and AI-related education. The high percentage of the participants who are single suggests that a large portion of those engaged with technology in schools are likely in the early stages of their careers or education, which could influence their adaptability and openness to integrating new technologies. This demographic information provides a valuable context for understanding the perspectives on the ICT and AI integration, particularly in terms of age, professional experience, and openness to innovation in the classroom.

Table 3

Ability of ICT and AI Schools in Pokhara

Options	Frequency	Percent	Valid Percent
High	33	25.0	25.0
Moderate	88	66.7	66.7
Low	11	8.3	8.3
Total	132	100.0	100.0

The study on the integration of ICT and AI in schools in Pokhara Metropolitan City assessed the perceived ability of these technologies to enhance education. In Table 3, among the 132 participants, 33 respondents (25.0%) rated the ability of ICT and AI as high, indicating a positive view of the potential impact of these technologies on learning. The majority, 88 participants (66.7%), reported a moderate ability, suggesting that while they recognize the value of ICT and AI, they may see room for improvement or face the challenges in their implementation. A smaller group, 11 participants (8.3%), rated the ability as low, reflecting the concerns about the effectiveness or integration challenges faced in their schools. This distribution highlights the varying levels of confidence in the role of ICT and AI in education, providing the insights into the factors influencing their adoption in Pokhara's schools.

Table 4

Familiarity of Participants with ICT and AI

Responses	Frequency	Percent	Valid Percent
Always	75	56.8	56.8
Never	10	7.6	7.6
Sometimes	47	35.6	35.6

Responses	Frequency	Percent	Valid Percent
Always	75	56.8	56.8
Never	10	7.6	7.6
Sometimes	47	35.6	35.6
Total	132	100.0	100.0

The study regarding the integration of ICT and AI in schools in Pokhara Metropolitan City assessed the participants' familiarity with these technologies. Of the 132 respondents, as shown in Table 4, 75 participants (56.8%) reported being "always" familiar with ICT and AI, indicating a strong and consistent engagement with these tools. A smaller group, 47 participants (35.6%), stated that they were familiar "sometimes," reflecting intermittent exposure or usage of ICT and AI in their educational activities. Only 10 respondents (7.6%) indicated that they were "never" familiar with these technologies, suggesting limited or no interaction with digital tools. These results demonstrate a generally high level of familiarity with ICT and AI, though some barriers to full engagement still exist, highlighting the areas for further support and training in schools.

Table 5

Difficulties with ICT and AI Experienced by Participants

Responses	Frequency	Percent	Valid Percent
Yes	55	41.7	41.7
No	58	43.9	43.9
Don't Know	19	14.4	14.4
Total	132	100.0	100.0

The study on the integration of ICT and AI in schools in Pokhara Metropolitan City examined the difficulties experienced by participants in utilizing these technologies. Among the 132 respondents, as shown in Table 5, 55 participants (41.7%) reported encountering difficulties, indicating the significant challenges in accessing or effectively using the ICT and AI tools in the educational settings. A slightly higher proportion, 58 participants (43.9%), did not face the difficulties, suggesting smoother experiences with integration. Additionally, 19 respondents (14.4%) were unsure, indicating uncertainty or lack of awareness regarding the challenges associated with the ICT and AI usage. These findings highlight that while many educators and students are successfully integrating technology, there is a considerable portion facing the difficulties that may require the targeted support and solutions to optimize digital learning.

Table 6

ICT and AI Ability of Learners

Responses	Frequency	Percent	Valid Percent
Yes	118	89.4	89.4
No	6	4.5	4.5
Don't know	7	5.3	5.3
No response	1	.8	.8

The study on integrating ICT and AI in schools in Pokhara Metropolitan City explored the importance of learners possessing ICT and AI abilities. In Table 6, a significant majority of respondents, 118 participants (89.4%), agreed that learners must have the ICT and AI skills to succeed in modern education. This reflects a strong belief in the importance of digital literacy for students' academic and professional futures. A smaller group, 6 respondents (4.5%), disagreed, while 7 participants (5.3%) were uncertain about the necessity of these skills. Only 1 respondent (0.8%) did not provide a response. The overwhelming consensus underscores the recognition of ICT and AI as essential competencies for students, highlighting the need for the educational institutions to prioritize the digital skills development in their curricula.

Table 7

The Use of ICT and AI at Home

Responses	Frequency	Percent	Valid Percent
Always	44	33.3	33.3
Sometimes	84	63.6	63.6
Never	4	3.0	3.0
Total	132	100.0	100.0

The study on the integration of ICT and AI in schools in Pokhara Metropolitan City also examined the use of these technologies at home. Of the 132 participants, as shown in Table 7, 44 respondents (33.3%) reported using the ICT and AI tools "always" at home, indicating a consistent engagement with these technologies outside of school. The majority, 84 participants (63.6%), used them "sometimes," suggesting that while these tools are regularly accessible, their use may not be continuous. Only 4 respondents (3.0%) indicated that they never used ICT and AI at home. This data highlights the significant role that the home usage plays in familiarizing students and teachers with the digital tools, supporting the notion that a consistent interaction with technology both at school and at home is crucial for effective integration into education.

Table 8

Satisfaction with the Use of ICT and AI

Responses	Frequency	Percent	Valid Percent
Yes	99	75.0	75.0
No	10	7.6	7.6
Don't know	23	17.4	17.4
Total	132	100.0	100.0

The study on integrating ICT and AI in schools in Pokhara Metropolitan City also assessed the satisfaction of participants with using these technologies. In Table 8, a majority, 99 respondents (75.0%), expressed satisfaction, highlighting the positive impact of the ICT and AI tools on their educational experiences. In contrast, 10 participants (7.6%) were dissatisfied, suggesting some challenges or limitations in their use of technology. Additionally, 23 respondents (17.4%) were uncertain, indicating either a lack of exposure or an unclear understanding of the technologies' effectiveness. The data suggest that while a significant number of educators and students are satisfied with ICT and AI integration, there are some areas where significant improvements can

be made to increase the overall satisfaction and to address the concerns related to the technology use.

Figure 1

Integrating ICT and AI in Classrooms

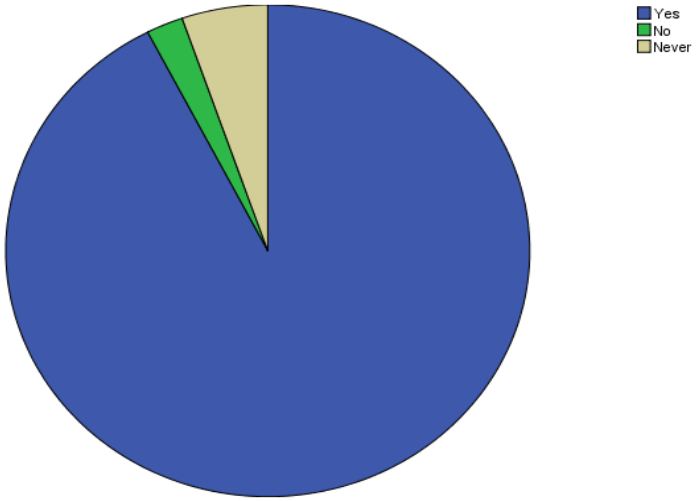

Figure 1 presents the distribution of responses regarding the impact of ICT and AI on classroom education. A significant majority (92.4%, n = 122) of respondents believe that ICT and AI contribute positively to the educational development. A small percentage (2.3%, n = 3) expressed that ICT and AI do not enhance classroom education, while 5.3% (n = 7) stated that they have never used these technologies in education.

These results indicate a strong support for the integration of ICT and AI in the classrooms, highlighting their perceived benefits for improving the learning experiences. The minimal opposition suggests that most educators and students recognize the value of these technologies in education.

Table 9

Benefits of Learning ICT and AI Skills

Responses	Frequency	Percent	Valid Percent
Yes	110	83.3	84.0
No	8	6.1	6.1
Never	13	9.8	9.9
Total	131	99.2	100.0

The study on the integration of ICT and AI in schools in Pokhara Metropolitan City also investigated the perceived benefits of these skills in daily life. In Table 9, a majority of respondents, 110 participants (83.3%), recognized the value of the ICT and AI skills in day-to-day activities, reflecting the widespread acknowledgment of how digital literacy enhances everyday tasks. A smaller group, 8 respondents (6.1%), disagreed, indicating that they do not see the direct benefits of these skills in their routine life. Additionally, 13 participants (9.8%) reported that they never experience such benefits, suggesting limited exposure or application of ICT and AI in their daily routines. The data highlight the significant role of ICT and AI in everyday life for most individuals, while pointing to the areas where further awareness may be needed.

Table 10

The Use of ICT and AI in Classrooms

Responses	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	105	79.5	79.5	79.5
No	19	14.4	14.4	93.9
Never	8	6.1	6.1	100.0
Total	132	100.0	100.0	

The study on the integration of ICT and AI in schools in Pokhara Metropolitan City examined how frequently these technologies are used in the classroom. In Table 10, a majority of respondents, 105 participants (79.5%), reported using the ICT and AI tools in their classrooms, indicating a widespread adoption of these technologies for the educational purposes. In contrast, 19 participants (14.4%) did not use ICT and AI in the classroom, while 8 respondents (6.1%) indicated they never used these tools. These results suggest that while a significant number of educators and students are actively incorporating ICT and AI into their teaching and learning activities, there remains a smaller group who may face barriers to full implementation or lack of access to these technologies.

Figure 2

AI Application in Learning Process

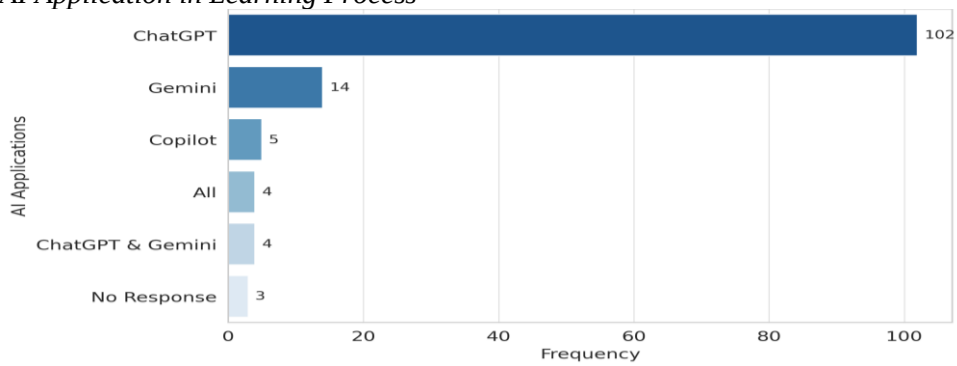

Figure 2 illustrates the distribution of AI applications used by students and educators in the classroom. The findings indicate that ChatGPT is the most frequently used application, with 102 respondents (77.3%) reporting its use. Gemini follows with 14 respondents (10.6%)**,** while Copilot is used by 5 respondents (3.8%)**.** Additionally, 4 respondents (3.0%) reported using both ChatGPT and Gemini, and another 4 respondents (3.0%) used all listed AI applications. A small percentage **(**2.3%, n = 3**)** did not report using any AI tools.

These results suggest that ChatGPT is the dominant AI tool in the classrooms, demonstrating its high adoption for the educational purposes. However, the presence of other AI tools, such as Gemini and Copilot, reflects a growing diversification in AI-assisted learning, indicating an increasing interest in utilizing the multiple AI tools for the educational enhancement.

DISCUSSION

The study on integrating ICT and AI in schools within Pokhara Metropolitan City presents the valuable insights into the current status and impact of these technologies. The findings highlight that the majority of respondents are in the younger

age brackets, particularly 14 to 18 years old, which reflects the youthful demographic of students and educators engaging with these technologies. The gender distribution was nearly equal, with a slight edge for males, ensuring diverse perspectives.

The participants generally rated the ability of ICT and AI to enhance education as moderate to high, with a significant number expressing the familiarity with these technologies. However, a substantial portion reported experiencing some difficulties in accessing or utilizing ICT and AI, indicating the challenges in implementation. Despite these challenges, most respondents believed that learners must possess the ICT and AI skills for academic and professional success. Furthermore, the respondents showed a satisfaction with the use of ICT and AI, recognizing their potential to improve classroom education. ChatGPT emerged as the dominant application, followed by other AI tools like Gemini and Copilot, underlining the growing trend of AI integration in learning. Overall, the study suggests a positive outlook on the integration of ICT and AI, while also identifying some areas for improvement in accessibility, training, and support for both educators and students.

This study on the integration of ICT and AI in schools of Pokhara Metropolitan City has several limitations that should be acknowledged. Firstly, the sample size of 132 participants may not fully represent a wider student and teacher population in the city, as the majority of respondents were from the younger age groups, with a limited representation from the older demographics. Furthermore, the sample predominantly consisted of some individuals who are single, which may skew the results, given that the younger students and teachers were more likely to participate. This may affect the generalizability of the findings to other population segments, such as the older educators or students with the different levels of experience in ICT and AI.

The study is limited to the geographical focus on Pokhara Metropolitan City, which restricts a broader applicability of the results to other regions of Nepal or countries with the different educational contexts, technological infrastructures, and cultural norms. The study also relied on the self-reported data, which is prone to biases, such as social desirability bias or recall bias. As a result, the responses might reflect the participants' perceptions or aspirations, rather than their actual behaviors or experiences with the ICT and AI tools.

Moreover, the study did not account for the variability in access to technology across different schools in Pokhara. Some schools may have a better access to the ICT and AI resources, which could influence the implementation and outcomes of these technologies. The study also lacks a longitudinal analysis, capturing only a snapshot of ICT and AI integration at a specific point in time. This limitation means that the study does not explore the long-term effects of these technologies on the student learning and teaching practices.

CONCLUSION AND SUGGESTIONS

In this way, the study has focused on specific AI tools such as ChatGPT and Gemini, without exploring the broader range of AI applications that may be relevant in the educational settings. This narrow scope limits an understanding of the full potential of AI in the classrooms. Future research could address these limitations by including a larger, more diverse sample, exploring the different regions, considering the long-term impacts of ICT and AI, and examining a wider variety of AI tools to provide a more comprehensive understanding of their role in education.

This study has made some suggestions to integrate ICT and Generative AI into the classrooms. They include the following:

- Increase Sample Size and Diversity: Future studies should aim for a larger and more diverse sample, including a wider range of age groups, gender balance, and representation from both single and married participants. This would provide a more comprehensive understanding of how ICT and AI are perceived and used across different demographic segments.
- Expand Geographical Scope**:** To enhance the generalizability of the findings, future research should include the participants from different regions of Nepal, as well as potentially from other countries, to capture a broader view of ICT and AI integration in various educational contexts.
- Longitudinal Studies: A longitudinal approach would provide the insights into the long-term impacts of ICT and AI on teaching and learning, allowing the researchers to track changes over time and better understand the sustained effects of technology integration.
- Focus on Technological Access: Future research should examine the variation in access to the ICT and AI tools across different schools, as this could significantly influence the outcomes of technology integration. Understanding the disparities in access can guide some interventions and policies to bridge the digital divide.
- Explore a Broader Range of AI Tools**:** The study could be expanded to include a wider variety of AI tools and applications used in the classroom, offering a deeper understanding of the diverse ways AI can support teaching and learning beyond just ChatGPT and Gemini.
- Use of Mixed-Methods Approach**:** Incorporating both quantitative and qualitative methods could provide richer data, helping to explore not only the extent of the ICT and AI usage but also the reasons behind their effectiveness or limitations from the perspective of educators and students.
- Training and Professional Development**:** Based on the challenges reported by the participants, future studies should explore the effectiveness of teacher training programs and professional development initiatives aimed at improving ICT and AI literacy among educators.
- Addressing Technological Challenges: Future research should identify the specific barriers that hinder the effective use of ICT and AI tools in the classrooms (e.g., technical issues, lack of infrastructure, or training) and propose some solutions to overcome these challenges.
- Incorporate Student Feedback: While this study primarily focused on teachers and educators, it would be beneficial to also gather feedback from students on their experiences with ICT and AI in the classroom, as their perspectives will be crucial for understanding how these technologies influence learning outcomes.
- Collaboration with Technology Providers: Partnering with the technology companies or educational software developers to customize the AI tools for the local contexts and needs could further enhance the effectiveness of ICT and AI in the classrooms of Pokhara Metropolitan City.

CONFLICT OF INTEREST DECLARATION

I hereby wish to declare that I do not have any conflict of interests to disclose.

AUTHOR CONTRIBUTIONS

I declare that this manuscript is originally produced by me.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the Professor Dr. Min Pun for his invaluable encouragement, guidance, and insights on AI in education, which have greatly influenced this study. I also appreciate my mentors, colleagues, and loved ones for their support. This research highlights generative AI's role in classrooms for sustainable development, inspired by scholarly contributions and technological advancements.

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To cite this article [APA 7th edition style]:
Baral, D. (2025). Integrating ICT and generative AI in classrooms for sustainable development: The case of schools in Nepal. *Academia Journal of Humanities & Social Sciences, 2*, 37-48. https://doi.org/10.3126/ajhss.v2i1.77159