Print ISSN: 2645-8500
https://doi.org/10.3126/mefc.v9i1.73879

Exploration of Opportunities and Challenges of Technology-based Mathematics Teaching: Students and Teachers Perspectives

Shree Prasad Ghimire and Krishna Chandra Paudel

Department of Mathematics Education, Mahendra Ratna Campus, Tribhuvan University
Corresponding Author Email: kcpaudel@ncit.edu.np

Abstract

The pervasive integration of Information and Communication Technology (ICT) in education necessitates systematic investigation of its practical effectiveness in mathematics instruction, as empirical evidence of its impact on teaching and learning processes remains crucial for enhancing pedagogical practices. This study investigated the opportunities and challenges of ICT integration in mathematics instruction among Bachelor of Education (B.Ed.) students majoring in mathematics and their teachers at Tribhuvan University. The information/data was gathered through interviews with eight students and four teachers who had studied and taught for various years (first, second, third, and fourth) using interpretative phenomenological techniques. From the study, it was found that high motivation, self-paced learning, conceptual understanding of contents, anytime-anywhere learning, opportunities for repeated learning, and feedback were the fundamental opportunities in the use of ICT. Furthermore, insufficient prior knowledge and skills on ICT use by both students and teachers, insufficient class time, less knowledge to prepare the course materials, less supportive infrastructure, insufficient access to ICT devices with internet, and availability of freely available software were found the challenges on the use of ICT.

Keywords: Challenges of use of ICT; Google Classroom, Mathematics learning; Opportunities of use of ICT

Introduction

The teaching, learning and comprehension of different mathematical concepts have all changed as a result of the incorporation of information and communication technology (ICT) into mathematics education. Interactive software, digital calculators, dynamic geometry software, and internet resources are examples of ICT technologies that give students practical experiences that help them comprehend abstract mathematical concepts. With the use of these tools, complicated problems can be

visualized, and students can experiment and change variables in real-time, which can help them to understand the problems better (Ghimire, 2024). ICT also facilitates differentiated education by providing a range of learning pathways, evaluations, and feedback systems that accommodate diverse learning styles. With the help of ICT, educators can create dynamic and interesting classes that encourage group projects, active learning and independent study.

Information and Communication Technology (ICT) is a collection of different hardware and software that is used to manage and connect data. ICT has altered how pupils learn in schools and has an impact on the environment in which they grow (Ainley et al., 2010). Technology tools include all digital and electronic gadgets, comprising the internet, computer and different multimedia equipment. The ability to create a more proactive teaching and learning environment, the use of ICT in classroom instruction is indispensable in these days. Teachers and students have been motivated to use ICT in their instructional practices for the supportive techniques to the conventional teaching methods (Khalid et al., 2014). ICT can improve education quality in a number of ways: by improving learner motivation and engagement, enabling the acquisition of foundational skills and improving teacher preparation. ICT offers transformational resources that if applied properly, support the transition to a learner-centered environment. ICT can improve education quality in a number of ways, including different new approaches of mathematics pedagogy. Consequently, ICT has a significant impact on learning ICT could be useful both advanced and struggling students. While advanced students can utilize interactive games and visual aids to investigate complicated topics can use them to better understand the concepts. ICT is not only the presentation of content through PowerPoint, it is useful for data analysis, simulation, and dynamic geometry as well as the use of different software that is included in the use of ICT. ICT in mathematics raises the issue of the development of broad skills that are applicable in all areas of mathematics. It helps to promote logical reasoning and interpretation of data which are the important aspects of the power of ICT use. ICT can be used to make content easy to understand as well as helps to develop and add depth to knowledge. Rather than merely memorizing the content, it helps in comprehensive understanding of shapes. Students can develop deeper ideas and encourage higher-order thinking through the manipulation and visualization of elements in mathematics.

ICT works as a motivator for educators to carry out their function in education as well as a tool for teaching and learning (Zakaria, N. A., & Khalid, F., 2016). Different

researchers (Gabare et al., 2014; Khalid, 2014) have highlighted that ICT in the classroom could introduce students to a variety of skills in using different applications and databases related to their future needs, such as Word sheet, Microsoft PowerPoint, Excel sheet, email, Google forms, Google doc, Google classroom and the internet for lifelong learning process. Educators can also use ICT to access information outside of their networks, changing the way the students are taught and how they gain knowledge and skill. The use of ICT aims to improve and enhance both the students' learning and the instructional capacity and skill of the teachers (KPM, 2013).

Additionally, it is the process of embracing new technology in different teaching and learning settings whether they are within the classroom or outside of the classroom (Nur Qistina & Hazman, 2006). The use of ICT in education could help improve students' ability to meet global needs by developing their skills and knowledge (Storm, 2011), as well as improve their ability to work cooperatively through society of practice (Khalid et al., 2014). Basri et al., (2018) said that use of ICT in the mathematics instructional process increases the achievement of the student. Among the different free applications provided by the Google such as Google forms, Google docs, Google sites, Google classroom; and free mathematical software such as GeoGebra mostly have been used as application tools in teaching and learning mathematics by Nepalese teachers and students. Besides these, the video tutorials available on YouTube are also popular among the teachers and students.

In the context of ICT use in the pedagogy, the different studies were focused on the problems obstacles that exist in teaching and learning mathematics in school level whereas B.Ed. level is one of the fundamental education for the preparation of future teachers in secondary level. Most of the schools in Nepal have started to use ICT in their teaching and learning with the support of government as well as non-government agencies. Schools are expected to have ICT trained teachers in their schools. Students studying in B.Ed. level are needed to acquire the ICT knowledge and skills for effective teaching but there was no such study related to the status of ICT use among B.Ed. level students and teachers teaching them. This study is exploring what difficulties and challenges are faced by the bachelor level students and corresponding teachers while acquiring the knowledge and skills on the use of ICT. To fulfill the above gap related to the challenges of bachelor level students in the process of acquiring knowledge and skills through this research the following objective has been constructed.

Objectives of the Study

The objectives of this study were exploration of the different opportunities that were realized by the teachers and students in mathematics teaching and learning, and it is also intended to identify the challenges of the use of ICT in mathematics pedagogical practices. To fulfil the above objectives related to the application of ICT in mathematics teaching and learning, the following research questions were formulated.

1. What are the opportunities on the use of ICT in mathematics instruction?
2. What are the different challenges in the use of ICT in mathematics instruction?

Application of ICT in learning mathematics was divided into two parts: the first part was related to the different opportunities that teachers are getting using ICT, whereas the second part was related to the challenges of teachers and students in the use of ICT.

Literature Review

On the aspect of challenges to the use of ICT in mathematics education in Nepal, different studies that highlighted issues such as visualization of mathematical concepts, simulation of real-world problems, enhancement of collaborative and cooperative learning, customization of education and evaluation system, development of computational thinking as well as interactive digital and educational resources. Through the interactive representations by using ICT tools students can understand the concept of difficult and abstract topics like transformation and graphs, function etc. From the interactive visualization of algebra and geometry through the different dynamic software such as GeoGebra, Desmos it is easy to understand the abstract concepts (Highfield & Goodwin 2013, Chandra & Sharma, 2018). As highlighted by Kerr and Bryans (2019), ICT helps to simulate real-world problems by applying mathematical ideas. It assists the students in seeing the practical application of mathematical models that boosts motivation and comprehension. Moreover, the use of ICT encourages the students' participation, increases the interaction that aids the development of mathematical reasoning and increases the capacity for communication abilities (Roschelle et al, 2000, Means et al. 2010). Teachers can more effectively analyze students' capacity and weaknesses by modifying the lesson through ICT that helps to grasp the mathematical concept.

Moreover, researches indicate that offering focused intervention of different technologies enhances the academic performance of students (Pane et al., 2013). Coding in mathematical algorithms improves students' capacity for the development of logical

thought and problem-solving. Students can enhance their computation skills which are essential in their workforce for solving different mathematical problems (Grover & Pea, 2013; Weintrop et al., 2016). Students can adjust different activities related to their skill levels and work at their own speed with the help of mathematics applications including online resources that help to provide feedback and use it for scaffolded skill reinforcement on platforms such as Khan Academy, Mathway etc (Cheung & Slavin, 2013)**.** In the context of challenges in the use of ICT in classroom instruction, Ghimire (2024) found that different constraints appear on the use of ICT such as cost, sustainability, equity and access including skilled human resources for the effective use of ICT. In the context of the teachers' perception and challenges of using ICT in teaching mathematics at the secondary level found that lack of knowledge, confidence, experience, training, enthusiasm and access to ICT tools were the main challenges in the use of ICT in mathematics. Moreover, the lack of technical support, absence of actual ICT software and unstable and inconsistent internet facilities at schools were the fundamental problems in the use of ICT (Adhikari, 2021).

Research Methodology

The design of the study was the interpretative phenomenological study to explore the lived experiences of students and teachers. ICT use in learning and teaching in different years of B.Ed. programme. We adopted the phenomenology in our study because phenomenology is a rigorous and unbiased study that investigates a phenomenon to achieve an essential understanding of human consciousness and experience (Husserl as cited in Dowling, 2007). Further, a phenomenological study describes the meaning for several persons of their lived experiences of a concept or a phenomenon (Creswell, 2007). The data were collected qualitatively through the interview of selected sample teachers and students and observation of their classroom.

Population

The population of this study was all the students studying mathematics in B.Ed. level in different affiliated and constituent campuses located at Kathmandu district under Tribhuvan University.

Sample of the Study

For the collection of data about the opportunity and challenges on the use of mathematics classes, eight students i.e. two from each class of B. Ed 1st, 2nd, 3rd and 4th

year randomly selected. Similarly, four teachers teaching in corresponding classes were chosen for the interview on the use of ICT in their respective subject. The opportunities and the challenges were discussed on interview. For the collection of interview data, researchers have recorded the interview of each of the participants about the proper use of ICT in pedagogical practices in mathematics.

Data Collection and Analysis Procedure

For the purpose of collection of data, the researcher has prepared the interview guidelines for teachers and students about the use and importance of the ICT in their classroom. The validity of the interview guidelines was also discussed with the three university professors and two schools' teachers as expert judgments. With the suggestions and feedback provided by them related to language as well as contents coverage in interview guideline were discussed and modified accordingly for the validity of the data. The final form of interview was also conducted to a teacher teaching in bachelor level and one student studying in fourth year to avoid the ambiguity in the interview guideline as a final form of validation of interview guidelines.

The interviews were conducted with the students and teachers teaching in different papers of mathematics first, second, third and fourth-years students. Qualitative information was analyzed by organizing the ideas about intrinsic and explicit meanings in thematic form (Flick, 2015). The data analysis was done to explore conceptual issues in the experiences of participants (Best & Kahn, 1999). In this research, the thematic method of data analysis method was applied to identify the importance of the experiences of the research participants to explore the patterns or themes within qualitative interview data (Braun & Clarke, 2006; Clarke & Braun, 2013). Regarding the conceptualization of meanings from the voice of the participants and interpreting the obtained for meaning making (Lochmiller, 2021). The collected data were categorized into different themes discussed below.

To enhance the trustworthiness of study, the researchers have followed different strategies. In-depth interviews and observations to gather comprehensive and accurate data, participants review and verification of the accuracy of the researchers' interpretation contributed to ensure the credibility of the study. The detailed descriptions of the research context, populations and relevant background information of the participants applied to enhanced the study's transferability. The researchers tried to follow clear and transparent process of research process so that others can replicate the study and justify its findings thus enhancing dependability of the research. The

participants reviewed and provided feedback on the researchers' interpretations contributed to the conformability of the study.

Meaning Making

The research aimed to explore the factors that contribute to indifference towards learning mathematics. The data for the study was collected through interviews with students and teachers, and the information were presented in the form of narratives. Eight students' and four teachers' narratives were analyzed and compared to identify the themes related to the participants' understanding and experiences regarding indifference to apply ICT in mathematics instruction. These narratives provided valuable insights into the factors influencing for the application of ICT in the pedagogical practices in mathematics.

Findings and Discussion

In the analysis of interviews collected from the respondents, the participants generated three major themes associated with previous experiences, existing practices, and existing challenges in the use of ICT in teaching and learning mathematics. Each of the constructed themes has been interpreted the narratives of the participants by exploring their major ideas and relating them to available literature and theories. The obtained information (data) was analyzed based on major three themes. These themes were justified by relating with kinds of literature and theories as below:

Previous Experiences in the Use of ICT

One of the students studying in B.Ed. first-year expressed his views in relation to his previous experiences in learning mathematics with ICT

I came from a village after completing my secondary education outside of Kathmandu. . It was very challenging to come here and pursue higher education due to my poor financial status. While learning mathematics from the primary class to 10+2 level I did not get any opportunity to use the computer. I didn't have computer at home. There were few computer in our schools but they did not function properly. We did not get any opportunities to learn the fundamental knowledge and skills on computer. There were no computer teachers who can teach us even fundamental skills of computer. Now I have come here to study B.Ed. level and planning to do job by learning computer skills and English language (Based on personal communication with a student on 12 April, 2024)

Another student of B. Ed. second year also shared similar views as

While learning mathematics from the lower grades through grade 12, I never had the opportunity to use a computer, nor did I have one at home. We did not get any opportunities to learn fundamental knowledge and skills on computers at the school level (Based on personal communication with a student on 12 April, 2024).

From the above representative narration of students, it is indicated that students were not getting opportunities to learn digital skills in their previous classes. Due to the lack of sufficient devices and skills in the use of ICT, it was very difficult to get the fundamental knowledge of ICT to them. Lack of previous knowledge and skills with teachers and student was one of the challenges on use of ICT in mathematics class. From these, it is concluded that teaching mathematics by using ICT from the junior classes is very important.

The sharing of knowledge and skills with each other is one of the important in the generation of new knowledge. Sharing knowledge and skills with sufficient interaction helps to broaden the knowledge and skills. As Vygotsky (1978) in his social constructivism theory suggested, social interaction is important for the extension of knowledge and skill. Integration with seniors, teachers and friends about the different knowledge and skills on the use of computers helps to motivate them in their learning. This finding reflects the lack of trained teachers and ICT resources at the school level that created the challenges at the college level. The findings of the research conducted by Joshi (2017) underlined the issues in the field of government and schools level and the need to concentrate on infrastructure management, human resources management, regular power supply in the institutions, providing the necessary ICT based applications for subject teachers, organizing awareness and training programs related to ICT, develop special video/documentary based on school curriculum and facilitate to each school. Due to the insufficient use of ICT in school-level, B.Ed. level students could not develop the ICT skills. In this case, this study is similar to the findings of the study conducted by Joshi (2017).

Existing Practices of Learning Mathematics with ICT.

In the context of students' existing practices in learning mathematics with ICT another student of B. Ed. second year of constituent campus has expressed her views as:

Teaching with new and innovative methods by using ICT is very interesting in learning mathematics. We got some classes in geometry by using GeoGebra application. I found very interesting to learn with this application. From this application, we can easily animate the geometrical figures according to our interest. While reading

geometry in class by using marker and white board, the figures that were drawn in the board were fixed. We cannot see all the dimension of figures that create the confusion in proving the different geometrical concept and prove of the theorem. When we got the opportunity to learn it in ICT, makes us clearer and more interesting. (Based on Personal Communication with a Students of B.Ed. Second Year, 2024)

From the above narrative of students, learning geometry by using ICT helps to make the concept clearer that generates the motivation and develops the interest in mathematics among the students. In this context, incorporation of ICT tools in the teaching and learning support positively in the achievement of students in mathematics (Maharjan et al., 2022).

The student's narration provides a firsthand account of the benefits of integrating ICT, specifically dynamic geometry software, into mathematics education. It highlights the potential of technology to enhance visualization, increase student engagement, and improve conceptual understanding in geometry. This aligns with current research in mathematics education and cognitive learning theories, suggesting that thoughtful integration of ICT can significantly enhance the learning experience and outcomes in mathematics education.

The low achievement of students in mathematics from school to university level is one of the great challenges in the existing context of Nepal. The low proficiency of students in the school level created the problems in the whole achievement of students in the application and higher level of mathematical knowledge. (MoE,2011/2013/2020) The lower proficiency in school level mathematics is reflected in higher level. Mathematics learning is possible if the students have essential fundamental knowledge and skills of the previous classes in mathematics as it could be easier to learn the new concept in the successive classes. Different method and approaches in teaching mathematics are searching for the enhancement of learning proficiency in mathematics. In this context, the technological use in teaching and learning in mathematics became a prominent approach in mathematics teaching. Different research such as (Basri et al., 2018; Bhagat, 2015) highlighted the increase in achievement of the student with the use of ICT in the mathematics instructional process.

Existing Challenges for Teachers to Use ICT in Teaching Mathematics

Highlighting the different challenges faced by teachers in teaching mathematics with ICT expressed his views below. One of the teachers teaching in B.Ed. the first year has expressed his view on the use of ICT pedagogical practices in mathematics as:

Most of the students/schools in Nepal have no opportunity to use ICT in pedagogical practices. Only a few students at the B. Ed. level have previous knowledge of computers and other ICT tools. Even in bachelor's level, they do not have adequate access to the basic knowledge and skills of ICT. Neither they get access due to their economic barrier nor does the campus/university provide such an opportunity to them.

Further, a teacher teaching B.Ed. fourth year has expressed his view on the use of ICT in mathematics teaching as

The use of mathematics in higher level is very difficult in all subject. There is difficulties to prepare the ICT based teaching materials for teaching algebra, analysis as well as calculus. We don't have such skills to make them visualization. We don't have the sufficient knowledge on the preparation of such materials for teaching these subjects. Some of the application such as MATHEMATICA, GeoGebra, MATHLAB are very important to prepare ICT based teaching materials but due to insufficient skills to execute them created the problems. Out of these different types of mathematical application only GeoGebra is freely available software. Other all the applications are either paid or online software. They are very expensive. Further, we can use them as online version but the sufficient capacity of internet facilities in classroom is difficult to use in our day to day classroom. Further, there were only forty-five minutes class time, which is very short and insufficient time for the demonstration of mathematical model by taking students in ICT lab.

Similar, views is also expressed by the teacher teaching in B.Ed. third-year level of affiliated campus*:*

He also highlighted the access to ICT software, and necessary training for teachers the use of ICT in mathematics teaching is not applied in our classes. In some topics, we are trying to use ICT by taking the students in the ICT lab but most of the time it is not possible. Further, we don't have knowledge and skills in the use of ICT in higher-level mathematics. We are not getting opportunities to take training /workshops on the use of ICT in higher-level mathematics but if we are able to show our content dynamically to our students it helps to motivate them in mathematics. It will be easy to make them understand the different mathematical concepts.

(Based on the personal communication with the mathematics teacher, 14 April 2024)

From the above views of mathematics teachers teaching in different years, the ICT-based approach of teaching is essential for a better understanding in mathematics

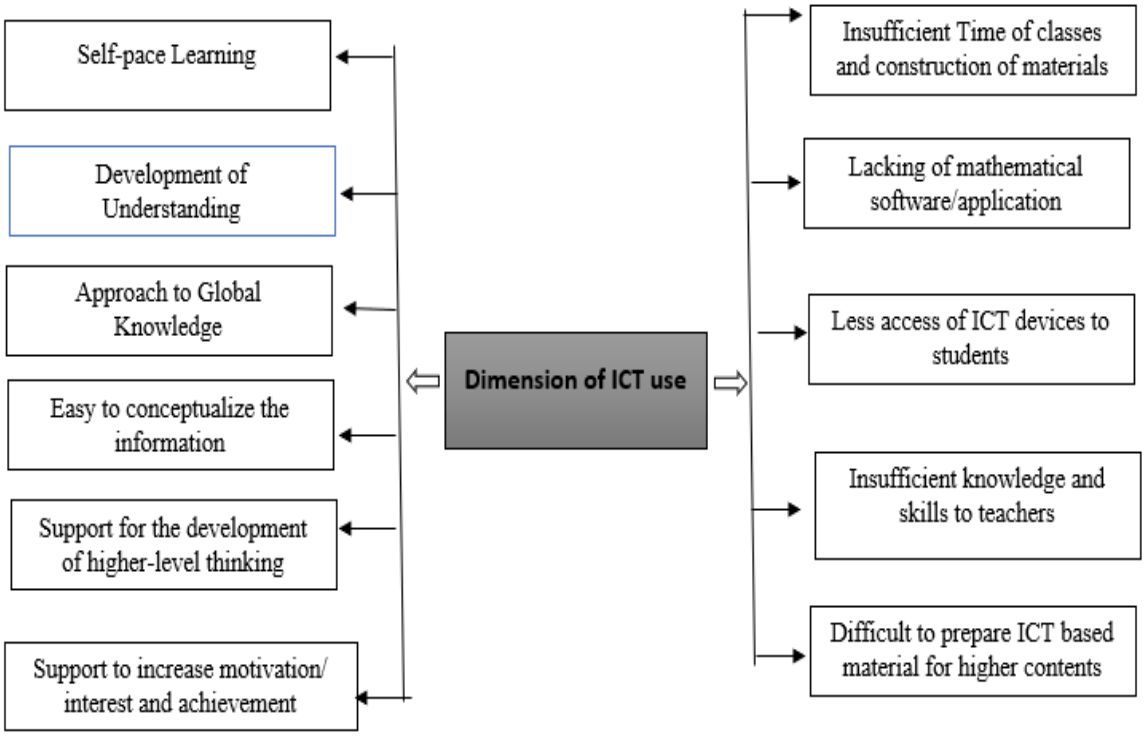
learning. But the access of ICT devices to students and teachers was one of the great challenges. Further, the unavailability of freely available mathematical software is also a challenge to ICT use. If teachers were provided sufficient training and access to different software related to mathematics subjects could support them to learn mathematics effectively. The limited access to resources and skills, insufficient class time and the opportunity of teachers to participate in different training were the main factors for the challenges to the use of ICT. On the contrary of that teacher have a willingness to learn the necessary skills in the use of different ICT applications in their teaching and learning. They believed that technological use in learning mathematics is very essential to enhance the student's achievement in mathematics (Maharjan et al., 2022).

The findings from teacher interviews revealed significant challenges in implementing ICT for mathematics teaching in Nepal's B.Ed. programs. These challenges primarily fall into three categories: access and infrastructure, teacher training and skills, and pedagogical concerns. Limited access to ICT resources, stemming from both economic constraints and institutional limitations, emerged as a major barrier. This aligns with Drijvers et al.'s (2016) identification of technology access as crucial for successful ICT integration in mathematics education. Additionally, teachers consistently reported insufficient knowledge and skills to effectively use ICT, particularly with advanced mathematical software. This echoes Mishra and Koehler's (2006) emphasis on technological pedagogical content knowledge (TPACK) for effective ICT integration.

Pedagogical concerns were also prominent, with teachers expressing difficulties in preparing ICT-based materials for advanced topics like algebra, analysis, and calculus. Time constraints, with 45-minute classes deemed insufficient for meaningful ICT integration, further compounded these challenges. These findings suggest a need for a multi-faceted approach to address ICT integration in mathematics education, particularly in developing contexts like Nepal. Such an approach should include improving ICT infrastructure, providing comprehensive teacher training, developing context-specific strategies for ICT integration in advanced mathematics, and addressing time constraints through curriculum redesign. Future research could focus on developing and evaluating interventions to address these challenges, as suggested by Ertmer and Ottenbreit-Leftwich's (2010) work on factors influencing technology integration in classrooms.

The summary of the opportunities and challenges of the use of ICT are highlighted in the following diagram.

Figure 1.
Opportunity and Challenges Dimension of ICT use for Mathematics Teachers and students



Conclusions and Implications

There are many advantages to use ICT in mathematics education for the improvement in students' performance and motivation. It also promotes the growth of a favorable attitude towards mathematics and improves compression of mathematical ideas. Nevertheless, there were number of disadvantages in using ICT, such as the requirements that instructors/teachers and students possesses the necessary abilities and knowledge, as well as the fact that having access to ICT tools and resources makes it easier to maintain and ICT friendly learning environment. These conclusions are supported by a review of various academic activities and empirical investigation. The insufficiency of technological knowledge among teachers, the decline in chances for ICT related training and education, and the lack of sufficient technical assistance all make the use of ICT in mathematics classes difficult.

One of the benefits of adapting ICT into teaching and learning mathematics is that it may support students' interaction in mathematics classrooms. Students benefit most from the e-learning portal when they are learning mathematics (Keong et al., 2005). Students' participation and sharing of different knowledge and skills is facilitated by the extended use of modern digital tools like GeoGebra, Math Sketch Pad, Photo Math, and other related programs.

Students were the main center of learning activities when the technology was used as a teaching tool, with educators serving as facilitators. The use of various types of freely available technological tools has improved students' knowledge development and increased their proficiency in cognitive learning. Students comprehend mathematical concepts better when ICT is used appropriately, it can raise interest in mathematics. Positive results were obtained while several geometrical theorems were dynamically proved using the GeoGebra application. Further, this software provides immediate feedback to help students recognize mistakes they have made in applying definitions, axioms, postulates, and concepts, as well as in supporting specific geometrical theorems. Using ICT helps with the development of critical thinking skills and compressions of geometry-related materials.

Different studies (like Condie & Munro, 2007 and Keong et al., 2005) looked at students' higher-order thinking skills while also pushing them to think creatively and unconventionally developing geometric conceptions. Additionally, using digital tools makes it easier to find appropriate answers quickly. For example, computer software created for kids pushes them to rewrite problems until they get the right answers. This approach indirectly increases students' drive to keep trying and their level of interest. This study was limited to a small sample of participants in the constituent campus of Tribhuvan University. Therefore, this research is less generalizable. Further, research in the field of ICT use in mathematics instruction in the university level is necessary.

References

Adhikari, G. P. (2021). Teachers' Perception and Challenges of Using ICT in Teaching Mathematics at Secondary Level. *Mathematics Education Forum Chitwan*, 6(6), 50-65.

Ainley, J., Eveleigh, F., Freeman, C., & O'Malley, K. (2010). *ICT in the Teaching of Science and Mathematics in Year 8 in Australia.* Australian Council for Educational Research http://www.ag.gov.au/cca

Basri, W. S., Alandejani, J. A., & Almadani, F. M. (2018). ICT Adoption Impact on Students' Academic Performance: Evidence from Saudi Universities. *Education Research International, 2018*, 1240197. https://doi.org/10.1155/2018/1240197

Best, J. & Kahn, J. (1999). *Research in education* (7th ed.). Prentice-Hall of India.

Bhagat, K. K., & Chang, C.Y. (2015). Incorporating GeoGebra into geometry learning-A lesson from India. *Eurasia Journal of Mathematics, Science and Technology Education, 11*(1), 77 –86. https://doi.org/10.12973/eurasia.2015.1307a

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. http://dx.doi.org/10.1191/1478088706qp063oa

Chandra, V., & Sharma, P. (2018). ICT in Mathematics Education: Pedagogical Aspects. *Education and Information Technologies*, 23(4), 1234-1251

Cheung, A., & Slavin, R. E. (2013). The Effectiveness of Educational Technology Applications for Enhancing Mathematics Achievement in K-12 Classrooms: A Meta-Analysis. *Educational Research Review*, 9, 88-113.

Clarke, V. & Braun, V. (2013). Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The Psychologist, 26*(2), 120-123. https://uwe-repository.worktribe.com/output/937596

Condie, R., & Munro, R. K. (2007). The impact of ICT in schools-a landscape review.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage

Dowling, M. (2007). From Husserl to van Manen: A review of different phenomenological approaches. *International Journal of Nursing Studies, 44*(1), 131-142

Drijvers, P., Ball, L., Barzel, B., Heid, M. K., Cao, Y., & Maschietto, M. (2016). Uses of technology in lower secondary mathematics education: A concise topical survey. Springer Nature.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255-284.

Flick, U. (2015). *Introducing research methodology* (2nd ed.). Sage Publishing. https://irigasi.info/wp-content/uploads/2021/04/introducing-research-methodology-uwe-flick.pdf

Gabare, C., Gabarre, S., Din, R., Shah, P. M., & Karim, A. A. (2014). iPads in the Foreign Language Classroom : A Learner's Perspective. *The Southeast Asian Journal of English Language Studies*, 20, 115-128

Ghimire , S. P. (2024). Two Poles on the Use of ICT in Mathematics Education: Opportunities and Challenges. *Pragyaratna प्रज्ञारत्न*, *6*(2), 153–160. https://doi.org/10.3126/pragyaratna.v6i2.70601

Grover, S., & Pea, R. (2013). Computational Thinking in K–12: A Review of the State of the Field. *Educational Researcher*, 42(1), 38-43.

Highfield, K., & Goodwin, K. (2013). Apps for Mathematics Learning: A Review of 'Educational Apps' in the Early Years. *Mathematics Education Research Journal*, 25(4), 547-559.

Joshi, D. R. (2017). Policies, practices and barriers of ICT utilization in school education in Nepal. *International Journal of Research in Social Sciences*, *7*(2), 408-417.

Keong, C. C., Horani, S., & Daniel, J. (2005). A study on the use of ICT in mathematics teaching. *Malaysian online journal of instructional Technology*, *2*(3), 43-51.

Kerr, J., & Bryans, A. (2019). Using Simulations to Teach Real-World Mathematics. *Journal of Educational Computing Research*, 57(2), 312-329.

Khalid, F., Joyes, G., Ellison, L., & Daud, M. Y. (2014). Factors Influencing Teachers' Level of Participation in Online Communities. *International Education Studies*, *7*(13), 23-32.

Kementerian Pelajaran Malaysia, KPM (2013). Laporan Awal-Ringkasan Eksekutif: Pelan Pembangunan Pendidikan Malaysia 2013-2025.

Lochmiller, C. R. (2021). Conducting thematic analysis with qualitative data. *The Qualitative Report*, *26*(6), 2029-2044. https://doi.org/10.46743/2160-3715/2021.5008

Maharjan, M., Dahal, N., & Pant, B. P. (2022). ICTs into mathematical instructions for meaningful teaching and learning. *Advances in Mobile Learning Educational Research, 2*(2), 341-350. https://doi.org/10.25082/amler.2022.02.004

Means, B., Toyama, Y., Murphy, R., Bakia, M., & Jones, K. (2010). Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies. *US Department of Education*.

Ministry of Education (2011/2013/2015). *National Assessment of Students Assessment Report,* Educational Review Office (ERO)*,* Government of Nepal.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017-1054.

Nur, Q., & Hazman, A. (2006). Penggunaan Teknologi Maklumat dan Komunikasi (ICT) dalam Kalangan Guru-Guru Seko lah Kebangsaan. Thesis, Johor Bahru: Universiti Teknologi Malaysia.

Pane, J. F., Steiner, E. D., Baird, M. D., & Hamilton, L. S. (2013). Continued Progress: Promising Evidence on Personalized Learning. *RAND Corporation*.

Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2000). Changing How and What Children Learn in School with Computer-Based Technologies. *The Future of Children*, 10(2), 76-101.

Storm, M. (2011). Cognitive Development: Cognitive Development (2nd ed., pp. 17-25). Amerika: American Institutes for Research.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard UP.

Weintrop, D., Beheshti, E., Horn, M., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining Computational Thinking for Mathematics and Science Classrooms. *Journal of Science Education and Technology*, 25(1), 127-147.

Zakaria, N. A., & Khalid, F. (2016). The benefits and constraints of the use of information and communication technology (ICT) in teaching mathematics. *Creative Education*, *7*(11), 1537-1544.

To cite this article:

Ghimire, S. P. & Paudel, K. C. (2024). Exploration of opportunities and challenges of technology-based mathematics teaching: Students and teachers perspectives. *Mathematics Education Forum Chitwan, 9*(1), 79-94.
https://doi.org/10.3126/mefc.v9i1.73879