TEACHERS' EXPERIENCES OF USING ICT IN TEACHING MATHEMATICS: A NARRATIVE INQUIRY

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AN ABSTRACT

of the dissertation of *Shree Krishna Acharya* for the degree of *Master of Philosophy in Mathematics Education* was presented on 6 January 2023, entitled *Teachers' Experiences of Using ICT in Teaching Mathematics: A Narrative Inquiry*

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Technology refers to the collection of tools that make it easier to use, create, manage, and exchange information. ICT stands for information and communication technology, which includes newer digital technologies such as computers and the internet. These are potential and powerful tools for the change and reform of education. ICT tools are the set of currently developed technologies that allow more efficient communication of information. This study focuses on inquiring teachers' experiences of using ICT tools in teaching school mathematics. I employed narrative inquiry as a research methodology within the paradigm of interpretivism. I used purposive sampling and selected four mathematics teachers as participants who were using ICT tools in teaching mathematics in community schools.

The study's result is that most mathematics teachers are trying to use GeoGebra software. But, due to the lack of effort and opportunity for the capacity development of many teachers, it is seen that they are not able to carry out the work easily. The use of ICT tools has developed modern teaching techniques in mathematics teaching and learning. It has supported professional development and enhances mathematics learning capacities, critical thinking skills of the teacher and

students, and formula derivation and application. It generates innovative ideas and motivates students to learn mathematics. The study concluded that the use of ICT tools is a suitable option to adopt for the advanced teaching and learning of mathematics according to time. For this, it seems that mathematics teachers should increase their skills in ICT and bring them to classroom in a practical way.

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I understand and agree that my dissertation will become a part of the permanent collection of the Kathmandu University Library. My signature below authorizes release of my dissertation to any reader upon request for scholarly purposes.

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DECLARATION

To the best of my knowledge and belief this thesis contains no material previously published by any other authors/scholars except where due acknowledgement has been made. This thesis contains no materials which have been accepted for the award of any other degree or diploma in any university.

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DEDICATION

This work is dedicated to my father Keshav Raj Acharya, my late mother Dil Kumari Acharya, my lovely daughter Krisha Acharya, and my lovely son Krish Acharya who made me always happy and encouraged me to complete my thesis work.

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CHAPTER I

INTRODUCTION

Information and Communication Technology (ICT) combines three words: 'Information', 'Communication' and 'Technology'. Information is mainly stated data, which may be recorded, organized, and interpreted within the content so as to convey meaning. Communication is largely the transfer of ideas and messages among people through different systems, devices, or media like computers, the internet, phones, telephones, TV, radio, social media, etc. Technology is usually defined as the making, adaptation, and usage of tools, techniques, systems, or machines for the purpose of solving problems or achieving goals in a very short period of time. Many institutions around the world have incorporated ICT into the teaching-learning process (Ismail et al., 2010). ICT has touched plenty of positive areas, in which teaching, and learning are the most significant aspects. Overall, ICT enables teachers as well as learners to show well, learn well, present well, work efficiently, share ideas easily, solve different problems easily, gain precise knowledge, and achieve goals in a shorter period of time. Also, it supports classroom teaching with the use of multimedia.

The combination of ICT in education has led to advanced independent knowledge, segregation of educational programs, learner-centered learning, consideration of higher arrangements, problem-solving, enjoyable learning, interpretation of theoretical concepts, and changes in understanding of subject material. Due to these various benefits, Nepal needs to encourage trainers to use technology to coordinate education with individual, collective, and institutional success. In addition to this, technology has also been successfully used in the fields of teaching and learning. This research has attempted to uncover aspects of teachers'

experiences of using ICT tools to support teaching and promote learning engagement in mathematics.

Regarding the pedagogical importance of ICT in education, it has revolutionized the way education is delivered and received. With the help of technology, teachers, though not all, are increasingly able to create multimedia materials and provide students with interactive learning experiences. Also, ICT has enabled students to access vast amounts of information and resources from around the world, which has greatly enhanced their learning experience and broadened their knowledge.

Proximity to Technology and my Experience

Today's need is to move ahead with times by connecting classroom with modern technology. “Technology is an extremely effective tool for involving students in mathematics instruction” (Dahal, et al., 2022, p. 65). Literatures show that there has been a growing interest in how to bring technology closer to the school level. Until the year 2059 B. S., while I was studying in school, I saw nothing but calculator as the use of technology. Most importantly, mathematics teaching and learning were mostly focused on scoring better marks/percentage/grades by using algorithmic problem-solving methods (Shrestha, 2018, 2019; Pant, 2015) that promoted procedural knowledge and skills rather than conceptual knowledge and understanding (Rittle-Johnson, & Schneider, 2015).

After the SLC exam in the year 2059 BS, the opportunity to take computer training was provided by an organization called The Reiyukai Nepal. I got three months of basic training at Durga Computer Institute in Damauli Bazar. After that, my interest in the field of technology increased. Until the year 2062 B.S., students studying in classes 11 and 12 could not get anything other than bookish knowledge. In

2012 AD, I decided to buy a desktop computer, realizing that I had not been able to put the knowledge into practice. Also, I was more interested to mobile phones. I managed NTC sim-card and brought a mobile phone at home. I used to feel easy to use technologies, but many of them were not easily accessible.

While studying at the undergraduate level, I decided to take up the field of media in Pokhara. When I went to New Star Media to take RJ/VJ training, I became more familiar with technology such as mics, recorders, and studios. After learning subjects like Typeshala, Paint, MS Dos, Word, Excel, and PowerPoint, I wished to learn a little more advanced courses. Until then, there was no accessible internet and no spaces for self-learning. With the available software and general knowledge, I started to learn on my own.

It intrinsically motivated me, and I continued learning. After going to Tribhuvan University Central Campus in Kirtipur for post-graduate studies, I came to know that mathematics can also be learned by combining it with technology. While studying at the postgraduate level, I got the opportunity to teach in a school located in a remote village in Ramechhap district. With the first four months' salary, I decided to buy a laptop. It is still with me.

While studying at Tribhuvan University, my attention was drawn to the animated software related to geometry. It was used by an Associate Professor. I started learning it. During the learning process, I was happy to be able to write and format all the post-graduate reports, notes, and dissertations. When the UGC provided twenty thousand rupees, the initial achievements gave me more encouragement and motivation to go further in higher education. During my teaching profession at Geetamata Secondary School, Dallu, I used to be ridiculed as a laptop teacher. There, I would use laptop for teaching. General educators believed technology was not

possible in community schools. But now, many of the classes in the school are taught in online mode. Many teachers use technology for teaching.

I got the opportunity to serve at Nava Adarsh Secondary School, Basantapur. In the morning, I continued my teaching at Oxbridge International College, Lalit Bahumukhi Campus, and in the evening, I studied at Kathmandu University. Being from a poor family, I was compelled to continue my teaching even in the most difficult circumstances.

With the admission to study at Kathmandu University, it was mandatory to have a laptop and internet at home. So, I connected internet at home. After having the internet at home, it was easy for me to get connected globally. In Kathmandu University School of Education, my focus was on technology. Wi-Fi, projector, sound system, microphone, smart TV, web camera, and CCTVs were used to teach students.

Teachers taught us using module. We had to submit assignments in the module. There were reading materials and presentation slides. Books, research papers, and other materials were e-copied. After studying a paper from Qatar in the third semester, I learned how a virtual class is possible. The use of technology in library was also attracting my attention. Seeing all this, I realized that it was possible to use technology in education. I began to look for the ways the community schools and the teachers integrate technology in teaching.

COVID-19: My Opportunity

Teaching was going on. Meanwhile, in 2072 BS, there was a great earthquake. The houses and belongings in Kathmandu were damaged. Life took a new turn as there were no living conditions in Kathmandu. I immediately returned to my hometown of Tanahun with my wife and little son in my arms. I observed that the earthquake had damaged my house as well. I was forced to spend a few days in the

tents. I tried to build a house even though I had a loan. After two months, I got the opportunity to teach in Tanahun. A few days later, I went to Kathmandu and looked at my room. My laptop and desktop computer were safe. There was no limit to my happiness.

Sometimes even natural disaster and epidemic may bring opportunities. Efforts were made to promote the use of technology in post-earthquake education. In this context, being affiliated to the technology-friendly teacher society since 2075 BS, I began to run training and public technical awareness programs for the teachers. The trainings were particularly on knowledge and skills related to technology. While running such a campaign, everyone used to joke that such a thing was not possible in a community school. I am proud that I started the campaign on time.

COVID-19 was an opportunity for me. Schools were closed. The concerned body could not think of any alternative other than physical presence. Everyone was just worried to survive. About 8-9 months' academic activities remained passive. The government of Nepal had no pre-preparation for creating teaching environment. The government had never imagined that this would happen in education. We brought together the teachers from all over the country through social media. It was necessary to enhance the capacity of the teachers for alternative learning. We began to share technical skills. Initially, there were 45 participants. After one month of training, we were happy to have 150-200 participants. When our campaign started, there were 500 participants in the virtual training at district level. With the introduction of alternative measures by the Government of Nepal, the demand for training increased. Teachers realized the need for and importance of such training. The number of participants increased.

Assisting the Education Training Center in initiating online training, I continued to take the lead in technology-related training. There were growing demands from various organizations at local levels and other education-related groups. Providing 15–16 hours of daily training to meet the demand from many areas, I did not even feel like I had time for food. Continuing this process, we ran the training programs free of cost by preparing a virtual room with an investment of around Rs 4 lakh through the Touch Sky Education Network in Damauli, Tanahu. I continued to learn and teach in the field of technology. Lately, I have been conducting training on alternative learning facilitation for schoolteachers in collaboration with local levels.

After gaining some knowledge about technology, the need for thematic training of teachers began to increase. I am still fulfilling my responsibility as its coordinator by forming a Mathematics Subject Committee composed of mathematics teachers from all over the country. Training programs on how to simplify mathematics were continued for 100 days from 8 p.m. to 10 p.m. By the time it reached the teachers, the participation on Zoom increased to over 1000. In particular, the use of GeoGebra in mathematics, easy math type, the use of digital materials and digital lessons or notes, the use of Google Classroom, the use of OneNote, online teaching and learning skills, and teaching and learning using various mathematics software and websites remained the focus of the program. We conducted the training on time. Living in this way and facilitating what the general teachers are trying to learn by contacting them has become a daily routine.

Therefore, it seems the Covid-19 created an opportunity for me to reach out to teachers all over Nepal, to get acquainted with various organizations, training centers, local level organizations, and to exchange the skills. It has been a challenge for me to

continue this campaign by giving it more time and keeping abreast of technological advancements in the field.

Statement of the Problem

ICTs have become an important aspect of people's daily lives. ICT tools have rapidly changed other important aspects of people's lives, including education. Rana (2020) argues that most countries in the world are focused on integrating ICT into teaching and learning activities to improve the quality of education. The poor performance of the students in the board examination is a matter of great concern for the government of Nepal. There are complaints from teachers and parents that students are not getting good marks in both internal and external examinations due to the current examination system. The results of the annual SLC/SEE examination showed poor student performance in mathematics (ERO, 2019). Furthermore, traditional teaching methods and insufficient use of ICT tools in mathematics learning are the main reasons for the low performance of Nepalese community schools. Teachers have been trying to develop technological teaching strategies through the appropriate teaching methods with the aim of attaining the desired change in behaviours of learners. But they have failed to realize that ICT tools can be patterned to the learners' interests to achieve an effective learning outcome.

Mathematics performance is directly related to the teachers' teaching strategy. Many teachers teach through the chalk and board method. They cannot use any teaching material, math software, and audio and video material. Because of this Lack of better instructional materials and technology, students are less engaged in learning (Ghavifekr & Rosdy, 2015). There are many other reasons to reduce students' achievement and their learning engagement.

When the government of Nepal decided to run online teaching and learning using technology as an alternative method, the curiosity about how to teach online was growing. By the time when the Educational Training Center in Gandaki Province conducted online training, the centers in other provinces could not start it. "What will happen to the teacher when the training institution is in a dilemma?" In this context, to connect the participating teachers while conducting training classes, I had to work hard. Looking at the learning conditions of the participants and the use of technology, I realized that they could learn if they were provided with opportunities. What is the condition of a general teacher in a rural area? The online training and learning process is organized by teachers' associations, organizations, local levels, teachers' groups, and thematic groups. During the learning process, there needed to be a digital learning campaign for teachers by developing software based on online and offline learning. A digital learning program was launched in collaboration. Vyas Municipality Tanahun was the first to demand it and it was implemented in 80 community schools in the municipality. After that, the demand for online and offline training increased, and the training was conducted as per demand in Bhimad, Myagdye, and Bhanu municipalities. It made me realize that there was a need for online and offline training sessions for schoolteachers.

There is no proper management of internet facilities and technology in the schools. Based on my experiences, the old mentality of the school headteachers has been an obstacle even if the teachers wanted to do. In many schools, computers are set up in the computer lab, but no progress has been made. This is what I have seen and experienced directly in school. My real experience is that I have not been able to use technology in teaching and learning activities in a practical way as I use the internet for entertainment only, particularly by using Facebook and YouTube.

Learning is an ongoing process. Learning and gaining knowledge is a continuous process that starts from birth and ends with death, and we can only gain benefit from it until we are alive. The online learning of the last two years has also given me some inspiration. At present, the use of technology and online business, teaching activities, mass media, administrative work, development of knowledge, skills, and abilities, vocational training, as well as higher studies are increasing. Now I am determined to move forward with the determination to use technology and continue my research on online learning as learning is possible through online resources. I have tried to move forward with the experience of the technology-related training I have done, so far. It has motivated me to do research concerning the attitude of the participants in the training as well as the time-relevant topics. This study investigates what and how secondary teachers are using ICT tools to support the teacher for teaching and promote students' learning engagement in mathematics. There is limited research in this area. Also, there is limited research on the usefulness of teacher professional development for technology integration by mathematics teachers in schools.

This study investigates how modern technology supports mathematics learning and how the use of ICT tools can increase students' engagement in math learning. Despite the growing trend of incorporating information and communication technology (ICT) into the classroom, there is limited research exploring teachers' experiences of using ICT to teach mathematics. It is not clear how the use of ICT by teachers is affecting their teaching practice. This study explores the experiences of teachers; the challenges faced by them and how it affects the learning outcomes of students. The specific questions that need to be addressed are related to the use of ICT tools to support teaching mathematics: what is the status of ICT tools used in teaching

mathematics in schools? What is the instructor and learner's perception about the use of ICT tools in teaching mathematics? What ICT tools can be used in schools to teach mathematics? Also, questions related to the use of ICT tools for promoting learning engagement in mathematics arise: what kinds of ICT tools can be used to improve students' learning engagement? How to use ICT tools to engage students in mathematics learning? What are the problems and challenges in using ICT tools in teaching mathematics?

Purpose of the Study

The purpose of this research study was to explore teachers' experiences of using ICT in teaching mathematics.

Research Questions

Based on my research problem, I developed the following research question: How do teachers narrate their experiences of using ICT in teaching mathematics?

Significance of the Study

During my teaching years, mathematics was considered a challenging subject. This is supported by annual SLC/SEE statistics, which show that less than 40% of all students taking the SLC/SEE examination found mathematics difficult (ERO, 2019). It is most important for students to learn 21st century skills and develop their ICT competence and ICT literacy, which improve students' achievement levels, prepare them for an integrated society, and use ICT as a lifelong learning tool. Therefore, there is a current need to give more attention to the involvement of ICT tools in the field of mathematics.

The main purpose of this study was to explore teachers' experiences of using ICT for teaching mathematics. ICT tools are used in the teaching activities, but those skills are not used in the appropriate way. This study is important in a way that it

explored how teaching and learning can be appropriately supported using ICT tools. Also, it explored the ways to create an environment conducive to student learning using ICT tools.

ICT helps teachers improve teaching methods, create multimedia materials, and provide students with interactive learning experiences. It also allows teachers to access a variety of information and resources and collaborate with peers from different parts of the world. ICT provides students with access to vast amounts of information and resources, enabling them to expand their knowledge and engage in self-directed learning. It also supports student-centered learning, providing students with opportunities to work collaboratively, communicate, and participate in interactive learning activities. ICT can help schools to improve their educational outcomes, increase their efficiency and effectiveness, and create a more engaging learning environment for students. By integrating ICT into the classroom, schools can better prepare students for the digital world and equip them with the skills necessary to succeed in the modern workforce. ICT provides researchers with access to vast amounts of data, enabling them to conduct more extensive and in-depth research. It also supports collaboration and communication between researchers, allowing them to work together on projects and share their findings more effectively. ICT can help teacher participants to develop their digital skills, improve their teaching practices, and enhance their professional development. By participating in ICT-enhanced learning programs, teacher participants can gain a deeper understanding of the use of technology in the classroom. They learn the ways to integrate it effectively into their teaching practices. ICT can inform policy decisions regarding the integration of technology into the education system. By providing valuable insights into the impact of ICT on teaching and learning outcomes, policy makers can make informed

decisions about investments in technology infrastructure and teacher training programs. So, this study helps teachers, students, schools, researchers, teacher participants, and the policy makers.

Delimitations of the Study

The data collected through narratives may be subjective and influenced by the personal experiences and perspectives of the teachers. The study is limited to two districts, four schools, and four school level mathematics teachers.

Various ICT tools which are helpful in teaching and learning mathematics were to be used. The study concentrated on a specific aspect of using ICT in mathematics teaching, such as teachers' experiences with a specific type of technology. Among them, only computer/laptop, projector, smart board, pen touch, calculator, mobile apps, math software, GeoGebra app, websites, social media, search engines and presentation tools were focused on in this research.

CHAPTER II

LITERATURE REVIEW

The related literature is the foundation of this study. The literature review reveals discussions in the literature about a topic. This chapter reviewed relevant literatures about the use of ICT tools to enhance teaching and promote students' learning engagement in mathematics. The thematic review addressed the themes of my research questions. The theoretical review provided theoretical guideline for my research. The empirical review supported me in identifying my research gap and methodology. This chapter deals with some literature that is related to my study.

Thematic Review

In the following section, I have reviewed the relevant literatures based on the following themes.

About ICT Tools

ICT tools are modern technologies used for student-to-student and student-to-teacher interaction, information flow, and mathematical concepts to engage with the latest concepts, including communication technology (Ghavifekr et al., 2021). Educational institutions use ICT tools to perform functions such as information communication, creation, dissemination, storage, and management. For these purposes, ICT has made a significant contribution to the modern digital age by bringing changes in the teaching and learning processes of mathematics. It has supported classroom management and virtual environments. The combination of hardware, software, multimedia, and delivery systems is today's new digital ICT (Howell, 2012).

Today, ICT in education encompasses a wide range of rapidly evolving technologies. ICT tools in education include different technologies such as desktop computers, notepad/notebook, laptop computers, digital cameras, mobile phones, the Internet, cloud computing, websites, excel sheets, tutorials, simulations, email, LAN, Bluetooth, live streaming, USB, and hard drives. It includes applications software like word, excel, PowerPoint, simulations, e-libraries, and video conferencing tools. ICT tools permit us to gain new knowledge through digital resources like e-libraries, where math learners and any other person can access learning materials and other related materials at the user's free time. All these are ICT tools used in the teaching and learning process of mathematics and other subjects.

ICT in Mathematics Teaching and Learning

In today's world, students are expected to use digital technologies to learn mathematics and prepare them for the challenges of the future, the world of work and everyday life (Kaushik, 2019). However, many national and international studies show that mathematics teachers have not yet been able to effectively integrate modern technology into their lessons. This study aims to review teachers' experiences of using ICT tools in the process of mathematics teaching and learning. International evidence suggests that one of the reasons teachers are not adopting ICT is the fear that ICT will replace them in the school system (Hudson & Porter, 2010). Some attribute the ineffective integration of ICT to lack of sufficient knowledge of ICT in mathematics education, lack of access to teachers, lack of motivation of teachers, and lack of adequate teacher training. Despite the benefits of integrating modern technology into mathematics teaching and learning, this poor integration is becoming increasingly problematic.

The use of ICT tools has the potential to transform the nature and processes of mathematics learning environments and envision a new culture of mathematics learning. ICT has expanded the possibilities of mathematics learning by enabling learners to access, extend, transform mathematics content and share ideas (Kaushik, 2019). Dahal et al. (2020) suggests that ICT tools can help learners share space with mathematics learning resources, facilitate a student-centered collaborative learning process, and improve critical thinking, logical thinking, innovative ideas, and problems in mathematics. It helps to improve problem-solving skills.

Using ICT tools is a modern way of teaching mathematics. It is important not only to use ICT tools but also to use ICT to improve mathematics teaching and learning. The major ICT initiatives in pedagogy are to enhance mathematics learning, motivate and engage learners, foster collaboration, promote learning through evidence-based learning in mathematics and inquiry, and develop new learner-centered approaches. It tends to create an enabling math learning environment. This enables a shift from educator-centered teaching and learning to autonomous, independent learning that fosters imagination and fundamental thinking in open-ended learning. ICT is designed to enable educators and undergraduates to communicate and collaborate across borders; help undergraduates achieve independence; and enable trainers to engage the world in their classroom practice. It is imperative to understand the role of ICT in advancing educational change. A basic guideline is that the use of ICT will change the distribution and ownership of data sets within the teaching and learning space, and thus, the relationships among teachers.

According to Kaushik (2019), "While designing any innovative teaching and learning environment using ICT, the teacher should always keep learning at the center of all activities; pedagogy should be at the heart; and integration of pedagogy and

technology should be the central focus."(p. 24) The challenges faced in operating a teaching and learning environment using ICT depend on the preparation and persistence of mathematics teachers. Through this research, the experience of mathematics teachers in the use of ICT tools in the mathematics classroom was checked. First, teachers must have good knowledge and skills in the basic use of ICT tools. They need to have skills to use these tools when teaching and learning mathematics. Efforts should be directed towards developing new mathematics to suit the modern environment by changing traditional ways of thinking. The main role for using ICT tools and integration for mathematics teachers is to promote learning engagement through student-centered pedagogy.

Theoretical Review

This study explores qualitatively, with the researchers guided by the Interpretivism philosophy. The different types of student-centered methods such as discussion and association, formula derivation, experimental verification, project work, problem solving, and practical work are used in the mathematics classroom. Furthermore, teaching and learning of mathematics is envisaged to utilize modern technologies such as graphic calculators, mathematics software, module learning, and computers that place mathematics in a realistic context. The constructivist view of mathematics for learners promotes interest and motivation and prepares the students effectively for the next century, paving the way for future generations.

Constructivist Perspective and ICT

Over the last few decades, innovative teaching and learning ideas have been prioritized. It is difficult to change the conventional view. Such views are often seen by students as empty containers waiting to be filled with knowledge. It is the learner who comes to class with it. Teachers are now becoming facilitators of learning rather

than reservoirs of knowledge. Students construct knowledge based on prior knowledge and experience rather than absorbing knowledge passively. Learners construct knowledge based on prior knowledge and experience rather than absorbing knowledge passively. From a pedagogic point of view, the student's learning activities should be directed at examining his own preconceptions and relating them to new knowledge. Learners often select and pursue their own learning. He also argues that 'constructivist theories recognize that real-life learning is messy and complex'.

ICT can be used as a tool to cultivate mathematical thinking. Computer applications have been adapted or developed to facilitate critical thinking and high-level mathematical learning. These tools enable learners to share and express what they know. Students act as craft designers (Jonassen et al., 1993). ICT is a powerful design tool for learners to construct knowledge. Multimedia place students in the designer's seat, allowing them to build their own understanding instead of interpreting the teacher's understanding of the world. Researching information, structuring, and designing presentations, and managing construction projects require critical and creative mathematical thinking skills.

Social Constructivist Perspective and ICT

The social constructivist approach is the most relevant educational practice in the 21st century classroom. Howell (2012) explains, "Social constructivism posits that social interactions precede the development of knowledge and understandings, which are in fact the end product of socialization and social interactions" (p. 23). A social constructivist technique may be achieved via the combination and use of ICT inside the classroom. This consists of interactive whiteboards, online instructional games, whiteboards, wikis, blogs, mobile devices, simulation tools, and social networking

sites. All the equipment is offered to college students with unique approaches to creating and constructing content effectively.

The social constructivist approach is more different from the traditional instructivist approach where "teachers set up the conditions for learning and then present information which is received by the student in a set sequence." (Finger et al., 2007, p. 118). In a social constructivist education center, the learners are responsible not only for their own learning but also for the learning of their peers.

When it is used properly and appropriately, technology can foster social association in ways far beyond what is possible in a regular teaching space. Ford and Lott (2012) state that "by integrating the powerful and common tool of technology, collaboration extends beyond the four walls of a classroom to communities around the world" (p. 17).

The successful use of technology in mathematics education is based on both teacher's and student's approaches to use technology in the classroom. Adopting attitudes can extend beyond math classes to school leaders. In addition, their awareness of ICT in the professional environment of teachers is of great importance. As a major player in the social constructivist approach, teachers are digitally savvy and an enabler of interactive mathematics classroom environments. It must be pedagogically based on its use. Researchers highlight some of the risks and challenges associated with the use of ICT for educational purposes. These demanding situations encompass the perceived usefulness of era inside the classroom, the disruptive nature of era as an academic tool, virtual literacy, and stages of self-assurance and talent in the use. Therefore, appropriate professional development activities or interventions should be substituted for these one-time training events.

ICT plays a critical role in supporting social constructivism as a theoretical framework for mathematical knowledge. Social constructivism emphasizes the idea that learning is a social process, and that knowledge is constructed through interaction and collaboration with others. ICT supports this view by providing tools for communication, collaboration, and representation of mathematical knowledge. ICT tools such as online forums, messaging apps, and video conferencing facilitate communication and collaboration between students and teachers. This provides opportunities for students to discuss and share their mathematical understandings with others, and to receive feedback and support from teachers and peers. ICT tools such as online collaboration platforms and virtual whiteboards enable students to work together on mathematical problems and projects, regardless of their location. This fosters a sense of community and increase opportunities for social interaction and collaboration in mathematics. ICT tools such as dynamic geometry software like GeoGebra, graphing calculators, and visualizations provide students with new and powerful ways to represent mathematical concepts. Also, it helps students to construct and communicate their mathematical knowledge in meaningful and accessible ways.

In short, ICT plays a crucial role in supporting social constructivism as a theoretical framework for mathematical knowledge. By providing tools for communication, collaboration, and representation, ICT help students to construct and communicate their mathematical knowledge in meaningful and accessible ways, and to participate in a social process of learning and problem-solving.

TPACK

TPACK stands for Technological Pedagogical and Content Knowledge. It is a principle that has evolved to explain the set of

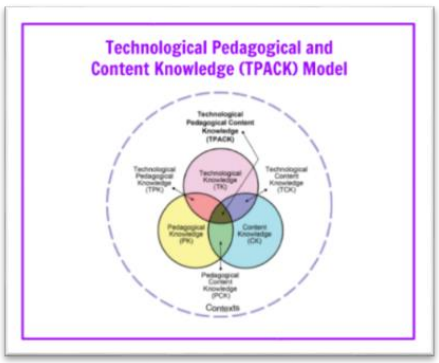

Figure 1: TPACK Model

skills that instructors want to use to educate their college students in a subject, educate effectively, and use technology. The TPACK model was developed in 2006 AD by Punya Mishra and Matthew J. Koehler in Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Mishra and Koehler developed a new framework in the TPACK after five years of research. It adds technology to the knowledge of educational content and emphasizes the connections, interactions, and limitations that teachers make across these three domains of knowledge.

Mishra and Koehler (2006) state that TPACK represents a class of knowledge that is central to teachers' work with technology. This knowledge would not typically be held by technologically proficient subject matter experts, or by technologists who know little of the subject or of pedagogy, or by teachers who know little of that subject or about technology TPACK represents a knowledge class that is central to a teacher's work with technology. This knowledge is not usually held by technically savvy subject matter experts, technicians who know little about the subject or pedagogy, or teachers who know little about the subject or technology.

The TPACK model provides a framework for understanding the interrelated nature of technology, pedagogy, and content knowledge and how they come together to support effective teaching and learning. The technology component of TPACK involves understanding the technological tools and resources available for teaching mathematics. In this study, the focus is on the specific ICT tools and resources used by teachers in their mathematics classrooms. The pedagogy component of TPACK involves understanding the theories and practices of effective teaching and learning. This study focuses the teachers' beliefs and practices related to using ICT in their mathematics classrooms. The content knowledge component of TPACK involves understanding the mathematical concepts and skills that students need to learn. This

study focuses on teachers' subject matter expertise and how they use ICT to support mathematics teaching and learning.

From TPACK, the researcher collects data on the ICT tools and resources used by teachers, the teachers' beliefs and practices related to using ICT in mathematics teaching, and the teachers' subject matter expertise. Then, the data is analyzed to determine how the technology, pedagogy, and content knowledge components of TPACK are interrelated and how they support effective teaching and learning of mathematics.

In short, the TPACK model provides a useful framework for understanding the interrelated nature of technology, pedagogy, and content knowledge and how they come together to support effective teaching and learning. By using the TPACK model in this research, the researcher gains a more comprehensive understanding of the teachers' experiences of using ICT in teaching mathematics and how these experiences impact student learning.

Empirical Review

The literature offers several ways to conceptualize how technology affects learning. Hudson and Porter (2010) researched on the topic ‘ICT use to improve mathematics learning in secondary schools. They used action research to include technology as a cognitive tool, ICTs as thinking and computing devices, and ICTs as tools for teaching student. Also, it included how computers work in acquiring cognitive skills, using ICTs as tools to improve student learning.

Regarding mathematics teaching and learning, teachers agree to use technology and applications to learn mathematics because ICT tools can influence and improve teaching and learning. Some researchers argue that mathematics teachers' beliefs can be viewed as purely subjective ideas about how they deal with

mathematics tasks and classroom practices. Just as teachers' views can influence the way learning environments are built, teachers also have views about the use of technology.

A study on the nature of beliefs about the use of technology in mathematics education conducted by Li (2007) recognized a few completely different perspectives of learning circumstances and the effect of computer use on convictions in science instruction. The study reveals that ICT tools conflict with beliefs among students and educators. In this case, students say they need to learn in a more successful, competent, and fun way. On the other hand, none of the faculty members in this study considered the benefits of computer innovation as an option over traditional classroom strategies to advance weak second-grade learning.

A study identified one of the issues related to the placement of beliefs and skills related to the educator's teaching perspective in the classroom, the development of social aspects, and the potential impact of the school and educational environment checked by the department. Their considerations also revealed that the type of expected development, and the use of exploratory computer programs played an important role in the type of mathematical activity in the classroom.

Research Gap

Much research has been conducted on the use of ICT tools, their usefulness, teachers' perception of ICT tools, students' perception, and the challenges of using ICT tools. In accordance with the current environment, ICT tools have been used a lot in educational activities after COVID-19. So, the experiences after using the ICT tools have been included in this research. Using the ICT tools in the classroom, the students have expressed their feedback to the teacher. In the Nepali environment, what kinds of ICT tools support the teaching process has been explored in depth. Unlike other

studies, it focuses on the experience of using ICT tools among teachers to increase the learning ability of students.

CHAPTER III

RESEARCH METHODOLOGY

In this chapter, I have introduced the research paradigm, research design, research method, research participants, and their selection procedures. I have introduced the procedures used in the study to collect field notes and narratives, their analysis process, and meaning-making. Information collection strategies, including quality standards and ethical considerations of the research have been discussed in this chapter.

Research Design

According to Teddlie and Tashakkori (2003), a research method is a method, procedure, or tool that produces perceptual, accurate, and moral information about a program. It is the research policies, methods, or procedures that are for the management of the information collected. Cohen et al. (2007) argue that "methods should be used as the basis for inference and interpretation, explanation, and prediction " (p. 35). Different philosophical beliefs about teaching, learning, and the role of technology influence the research questions, methods, and data analysis used in the study. This study followed a qualitative approach. Constructivist philosophy focuses on trust and exploration of how teachers use ICT to help students construct their own mathematical understanding through inquiry, reflection, and collaboration. Therefore, I used qualitative research methods. Under this, I conducted in-depth interviews and classroom observations on teachers' experiences and practices regarding the use of ICT in mathematics teaching for data collection. Qualitative data was used to find out about the pedagogical ways, teachers' and students' engagement and its status, teachers' experience of using ICT tools, the problems encountered while

using ICT tools, and efforts made in student engagement. The study assessed the present condition of educational institutions in the Nepalese community on the use of ICT tools in teaching and learning mathematics.

Philosophical Considerations

I have discussed ontological, epistemological, and axiological issues in relation to the teachers' experiences of using ICT tools for teaching and learning mathematics in this section.

Ontology

Ontology is concerned with the nature of reality (or being or existence). Various ontological perspectives reflect different prescriptions of what can be real and what cannot (Willis, 2007). In this study, different ICT tools were used in mathematics teaching and learning, such as in classrooms, homes, and schools. Different teachers participated from different backgrounds. The reality was different for each person according to their experiences. Also, the teachers came from different contexts, levels, environments, and experiences. It was the multiple realities in a particular context. In this study, these realities were derived from the teachers' subjective interpretations based on their experiences of teaching mathematics with ICT tools.

Epistemology

Epistemology is the study of knowledge. It is concerned with ways of knowing and learning about the social world. It is a philosophy that deals with how knowledge is constructed. It is concerned with the nature and forms of knowledge, how it can be acquired and how it is communicated to other human beings (Cohen et al., 2007).

In my research, I focused on producing subjective knowledge through different ICT tools and engaging learning with my research participants. My epistemology in relation to my research agenda was concerned with the teachers' experiences of mathematics teaching and learning with ICT tools for the mathematics classroom environment.

Axiology

Axiology is the philosophical study of value. It involves the values and belief systems of a paradigm, comprising the study of values. In this study, my concern was how the mathematics teachers valued the ICT tools in classroom teaching and learning. I listened to learn about the teachers' lives and teaching experiences and stories. From there, I made meanings by giving value to their ideas. I understood that axiology was concerned with the nature of human beings and their environments in particular. So, I respected the mental and emotional states of teachers and valued them. The ontology of this research was affected by subjective experiences and socially constructed values.

Research Paradigm

The research paradigm governs the researchers' queries into the policies and practices of education. According to Willis (2007), "A paradigm is thus a comprehensive belief system, world view, or framework that guides research and practice in a field" (p.8). This study explored teachers' experiences of using ICT tools for teaching school mathematics. So, I have chosen an interpretative paradigm that enables researchers to build rich local understandings of the life-world experiences of teachers and students and of the cultures of classrooms, schools, and the communities they serve (Taylor & Medina, 2011). Its social constructivist epistemology foregrounds the researcher's unfolding subjectivity in shaping the process of the

inquiry, especially the act of interpretation of the other's meaning perspective (Taylor, Taylor, & Luitel, 2012). I engaged to understand and interpret the real-life experiences of the teachers in teaching and learning mathematics with ICT tools. During the interview with the mathematics teachers, I focused on the beliefs, stories, and teachers' experiences in their classroom while teaching through ICT tools. This interpretive paradigm was facilitated to engage in the field for a longer period to understand my research participants' experiences, beliefs, and attitudes towards the roles of mathematics teachers with ICT tools for classroom teaching and learning.

Narrative Inquiry as Research Method

In this research, I used narrative inquiry as a research methodology. "Narrative inquiry is understood as a spoken or written text giving an account of an event, action, or series of events/actions, chronologically connected" (Finger et al., 2007). According to Connelly and Clandinin (1990), narrative is both a phenomenon and a method. They state that "education and educational research is the construction and reconstruction of personal and social stories; learners, teachers, and researchers are storytellers and characters in their own and others' stories" (p. 2). Narrative inquiry helped me generate and analyze my own and teachers' stories of their lives in the form of experiences of teachers with regard to teaching and learning mathematics with ICT tools. It typically focuses on studying a teacher, gathering data through the collection of stories, reporting individual teaching experiences, and finding and discussing the meaning of those individual teaching experiences using ICT tools. Employing narrative research design in my research study, I have focused upon the ICT tools used by teachers' experiences in teaching and learning mathematics through their stories, individual lived experiences, beliefs, and ICT-based classroom practices observed during field work. The purpose of narrative research is to study personal

experience and meaning making in a systematic manner (Willis, 2007). In this research study, I pursued narrative inquiry, focused on ICT tools, and utilizing teachers' experience in mathematics teaching and learning as a methodological approach for constructing reality in the form of narratives from informants.

Research Participants and Sites

As a narrative researcher, I relied on the research participants, which were gathered from their life experiences, thoughts, and stories. I intentionally selected individuals and sites to learn about or understand the central phenomenon (Creswell, 2012). I chose the four research participants purposefully who were using ICT tools for teaching and learning mathematics in community schools. All the mathematics teachers were chosen from the community schools in Tanahun district and Chitawan district. In the first stage, many teachers were contacted but four teachers were found who matched my research: two from Tanahun and two from Chitwan. Tanahun and Chitwan were chosen while searching for teachers who had technology facilities in schools and were teaching mathematics using ICT. My research participants were dedicated and experienced school-level mathematics teachers who taught with ICT tools in different schools.

Narrative Inquiry was useful to explore lives through individual experiences because human beings organize their experiences of the world into narratives and can be used to investigate how people frame, remember, and report their experiences. Thus, it allowed me to get an understanding of the complexities of human lives and endeavors. Through the process of narrative inquiry, during the interviews and other information collection processes, I tried to motivate the mathematics teachers to share their individual stories and experiences. At first, I conducted in-depth interviews and maintained diaries with each mathematics teacher regarding different phases of their

experience and story in teaching and learning mathematics with ICT tools. I asked for the interview, which I carried under four different categories, for three times. The first interview lasted around one hour. It helped the me to get the background and experience of their learning mathematics with ICT tools in formal educational settings. The second phase of interview was around one hour and thirty minutes, which helped me to get the in-depth stories on teaching and learning mathematics with ICT tools at the school level. The last phase of interview time was around one hour. It helped me to get the additional questions put forward during all phases of the interview sessions. After that, I organized the story and experiences in chronological order and transcribed the interview and made a note of it. Then I developed it into the narrative to further explore their attributes, experience, beliefs, and practices regarding teachers' experience in teaching and learning mathematics using ICT tools in the classroom.

Finally, I restored the stories told by the participants to code them into themes and subthemes. During the process, I focused upon narrating the stories shared by the research participants. I critically analyzed them to explore teachers' experience in teaching and learning mathematics with ICT tools. So, I chose narrative inquiry in my research because it goes to a different investigative level of teachers' experience in teaching and learning mathematics with ICT tools in the classroom. I also tried to drag out the experience and understanding of teachers' experience of teaching and learning mathematics with ICT tools in the classroom.

Tools and Techniques

As my research was qualitative research through narrative research design, I believed that an in-depth interview was an effective tool and technique for data collection to conduct my research more effectively and strongly. One-to-one

interviews with open-ended questions (Creswell, 2012) was the process of data collection in my research study. To acquire the necessary information for my study, it was crucial to invest a substantial amount of time with my research participants having prolonged interaction. Taking proper field notes provided an additional aid in receiving the required information. Different kinds of literature were studied to support my research study.

Interview

An important technique or tool to collect information in qualitative research design is the interview. The interview is a flexible tool for data collection, enabling multi-sensory channels to be used: verbal, non-verbal, spoken, and heard (Cohen et al., 2007). Interviews intend to provide detailed information on any topic. To ensure this, I conducted my research interviews with semi-structured questionnaires, which provided plenty of space to present their views openly. Furthermore, I tried to include the participants' teaching experiences and stories of ICT practice in the interviews. I worked immensely in making my questions short and understandable. The information they provided was encouraging to me to conduct my research study. But, to get additional information, I visited many mathematics teachers.

I used open-ended questions in the interview, made the field notes, and audio and video recordings of the interviews. The interviews were taken in two rounds. After receiving the narratives, experiences, and ideas of the research participants based on the interview questions, I prepared for the second interview to get in-depth knowledge about the roles of the mathematics teachers for classroom interactions.

Observation

Observation is a qualitative research method that involves directly observing and documenting the behavior, actions, and experiences of individuals in a natural

setting. Observation is used to gather rich and in-depth data about the research participants, their experiences, and their environment. In this research, researcher used participant observation tools. In participant observation, the researcher actively participates in the setting being studied and observes the behaviors and experiences of the participants from the inside. The researcher becomes part of the group or community being studied, gaining a deeper understanding of their experiences and perspectives. The researcher used this tool to collect data through participant observation method to observe classroom practice in mathematics teaching and learning.

Data Analysis and Interpretation

The information collected through various data collection tools and techniques was analyzed and interpreted wisely to make meaningful sense. It was really very difficult to draw the conclusion and relate the outcome to the research question and purpose. Qualitative data analysis involves organizing, examining, and explaining data. This means, understanding the data in terms of defining the participant's context and looking at patterns, themes, categories, and regularities (Cohen et al., 2007). For this, I transcribed the videos and audios that I had recorded during the interview and class observations. The data analysis process was then followed by systematic searching and arranging of field notes that I had collected to simplify my understanding and to facilitate my presentation of my findings in more effective ways. This process, I believe, necessitated the researcher's deep understanding of the data as well as the ability to elicit meaning from my research participants.

The data analysis and interpretation were carried out in a systematic manner. Initially, the collected data was organized and followed by presenting the findings accordingly. For this, I transcribed the data and wrote journals. After that, I continued

coding, categorizing, and generating themes. I conducted and noted down the important information points. Then, the findings were interpreted with critical analysis regarding the related theories and experiences. I read various scholars' literature, theories, and articles and attempted to form my own opinion based on those theories, articles, and literature. I performed data analysis and interpretation by considering these three parts as major steps (Creswell, 2012) of data analysis and interpretation in my research study. While interpreting the data, there is always some risk of misinterpretation of the collected data, leading to wrong conclusions. Proper attention was given to the data analysis process. For this, I went through both the audio and video recordings of the interviews with my research participants for multiple times to make sure that I did not miss any vital information or events.

Quality Standards

The quality standards are a process encompassing all aspects of study design. The quality standards of trustworthiness and authenticity in interpretative research are parallel to the validity, reliability, and objectivity standards of positivism (Guba & Lincoln, 1989). Besides this, my research preserved the following quality standards.

Trustworthiness

Trustworthiness is an important quality standard that every researcher must think about. Research results should be as reliable as possible, and each study should be evaluated in relation to the processes used to produce the results. Reliability criteria include reliability, transferability, and verifiability.

Authenticity

Authenticity is the quality standard of the research, referring to the relationship that the researcher has maintained with the participants. The authentic

criteria include fairness (the fairness in the representation of information), educative (if the participants are benefited by learning about their social world), catalytic (if the participants are benefited by knowing about the problems in their social world) and tactical (if the participants are empowered by the researcher to improve their social situation (Taylor & Medina, 2011). I remained careful in selecting the participants so that they can provide proper information about the use of ICT tools for me. I have made cross-queries about ICT tools during the interviews and discussions, if necessary. I did not evaluate their beliefs as right or wrong and also did not refer them to follow mine or any other's beliefs. I represented all their voices and beliefs about ICT tools.

Ethical Considerations

Every piece of research is highly sensitive to the moral character and ethics of the researcher. It is the ethical duty of the researcher to respect the beliefs, opinions, and ideas of the research participants in the research study. I focused on keeping in mind that the nature of the research participants and the environment in which the research process is being carried out can change the outcome of the research. This research is advantageous for all mathematics teachers, and it might be fruitful for students and administrators too. Hence, I emphasized setting up a good relationship with my research participants and also creating a comfortable environment in which the research was carried out. For this, I informed my research participants about the purpose of my study and how they were important as research participants. A good rapport with them played a vital role in assisting valuable information and data. Moreover, I was aware of an ethic of care that involves a deep and committed relationship that is based on mutuality, relatedness and trust among people (Luitel, 2009) throughout the research process.

Furthermore, talking about the ethical considerations of the research, I did not force the research participants with the aim of getting more information for my research. There was total freedom for them to get out of the research process whenever they desired. The process of the research was processed after the permission of the research participants and school administration. Similarly, confidentiality was promised, which means information or data provided by them was kept far from other people. Similarly, I was aware that there was no any type of physical or mental harm to the research participants during my research.

CHAPTER IV

TEACHER'S EXPERIENCES OF USING ICT TOOLS

In this chapter, I have discussed the background of a participant's first experience of using ICT tools; student's reflection after using ICT tools; support in math learning and preparing a lesson plan. They shared their experience of different challenges in using ICT tools in mathematics teaching and learning. I discussed their experience of enhancing learning capacity by using ICT tools in mathematics. During the process, I developed themes addressing the key research questions, which were based on the use of ICT tools for better mathematics teaching and learning.

Participant's Personal Stories About Using ICT Tools

Under this, the personal details of the participants' educational experience, the basis of selecting the participants, the situation of using ICT tools in student life, and their personal experiences when learning and using ICT tools for the first time are mentioned. The experiences of the participants during ICT learning and the ICT tools they used during mathematics teaching and learning are presented here.

Ashil's Stories about Using ICT Tools

I have explained how I approved Ashil's (Pseudo name) to be my research participant. Also, I have narrated how I collected his stories of a family and educational background, teaching and teacher profession, and experiences with ICT tools in teaching mathematics. I have narrated some narratives on each of them linking with related literature.

After getting ready for the interview with interview questions based on research questions, I approached Ashil's and decided to have him as my research participant. He met the criteria of being a research participant in my study that I had

set for my research. I conducted the first and second rounds of interviews in person, and the third round was conducted using the online Zoom conferencing tool. I recorded the audio and video conversations for evidence.

The name of the participant was Ashil, a resident of the Vyas Municipality-2, Tanahun. He was the father of three children, two daughters and one son. He had passed his SLC from Mahendra Jyoti Secondary School, Vyas-6, Tanahun in 2044 B.S. It was an old established school. He completed his intermediate level from Prithivi Narayan Campus, Pokhara, Kaski in the science stream. He passed bachelor level from the Aadikavbi Bhanubhakta Campus, Tanahun with majors in Economics and Mathematic. He completed one year of B.Ed. from the same institution affiliated with Tribhuvan University. He had been teaching mathematics for eighteen years since 2053 BS. Ashil was the Mathematics Teacher and Assistant Headmaster of Satyawati Secondary School. Also, he was the Assistant Lecturer of Aadikabi Bhanubhakta Campus, Vyas-1, Tanahun. He was the vice president of the Math Council, Tanahun, and a member of the Society of Technology Friendly Teachers' Mathematic Subject Committee, Nepal. He had been working as a rooster trainer at the Education Training Center, Gandaki Province, for a long time.

During the conversation, I asked Ashil- what kinds of ICT tools do you remember being used in your school life when you were a student? In this question, Ashil narrated his experience as follows:

> *I did not use ICT tools much until I gave my SLC from Shree Mahendra Jyoti Secondary School, Shishaghat in the year 2048 BS. A calculator was also prohibited from being used in SLC. Calculator could be used in SLC only from 2053 BS onwards. There was a trend of reading only the content and books that were taught by the teacher. Even practice books were not available at that*

time. I used a calculator only once while studying I. Sc. at PN Campus in Pokhara. At that time, there was a radio in the village, which was in my uncle's house. They used to go there to listen to the radio from all over the village. Even though I was a student, I used to listen to children's programs after 5:00 *pm and teacher training programs for teachers and enjoy them. Radio Nepal was the main communication tool at that time.*

Ashil joined the teaching profession from Gorakhkali Secondary School in August 2051BS. Later, he taught in a community school, Maharshi Ved Vyas Sanskrit Secondary School in Vyas-2. After that, he transformed from Chandi Devi Rastriya Secondary School. Currently, he was teaching at Satyawati Secondary School. After being involved in the teaching profession, Ashlil shared his experience of ICT as follows:

When I started teaching at Satyawati Secondary School, there were three Apple desktop computers. The computers were helped by someone. Because they were very old, they were not in a condition to be used practically, but they could be used at leisure time. I learned to type on it. It used to appear on the display only after two-three minutes of typing, but I had to learn to operate the computer.

When I started my master's degree in 2063BS, I also had to study a subject called ICT in maths. In addition to the office programs, programs like Foxpro, QBASIC were included. After the availability of computers, I started to work with office packages, creating documents as well as preparing presentations in Power Point. It was not possible to take them to class and use them. I talked

Figure 2: FoxPro Application

with math teachers who had heard that there was GeoGebra software that would be useful for math teachers while studying for a master's degree. But, it was not available. While going to a program in Pokhara, I knew from Bhesh Raj Mainali sir that it had been used in Nepal since 2002 AD. I raised the quarry of how to get it and how to use it.

In the year 2065 BS, we went to the cyber zone to use the internet by paying 20 rupees for ten minutes. In Cyber, we used to view websites and exchange emails. The Internet was not accessible to the public. Then, in the year 2069 BS, when the campus started teaching, the availability of computers was abundant. But there was no internet. At that time, we used to download the GeoGebra app on a pen drive and bring it to school and campus to install it. Attempts were made to use and learn offline. But due to the lack of tutorials and manuals, it was difficult. As a result, it was not possible to take what was learned to class and show it to students.

Bigal's Stories about Using ICT Tools

I approved Bigal (pseudo name) to be my research participant and collected his stories concerning family and educational background, teaching and teaching profession, and using ICT tools in teaching mathematics. After getting ready for the interview with interview questions based on research questions, I approached Bigal and decided to have him as my research participant. He met the criteria of being a research participant in my study that I had set for my research. I conducted the first and second rounds of interviews in person. The third round was conducted using the online Zoom conferencing tool. I recorded the audio and video conversations for evidence.

The name of the participant was Bigal, a resident of Bharatpur metropolitan city of Chitawan. He was the father of two children, one son and another daughter. He had a business in his own home, and his wife was running the business. He passed his SLC from Madi Secondary School, which was the popular public school in his own locality. He completed his intermediate level from Tribhuvan University in the Humanities stream with a major in English and the education. He had passed the bachelor's level from the Saptagandaki Campus and had completed his master's degree in private from Tribhuvan University. He had been teaching mathematics for seventeen years, starting in 2052 BS. Currently, he was working at the Shree Sitaram Sanskrit Secondary School, Bharatpur Metropolitancity-1, Chitawan.

Bigal's stories regarding the use of ICT tools are as follows*:*

I remember that when I was a student, I had to pay ten rupees to see the results from Gorkhapatra. Generally, teachers and students used to operate simple calculators, but scientific calculators were developed only later. For listening in English, tape recorders were used. We would listen radio's 'Teacher Education Program'. The reliable means of communication was Radio Nepal itself. We used to hear the BBC program at 9:45.

Even after entering the teaching profession, ICT tools were not used much for many years. My first experience with technology was the PowerPoint slides that I used in the three-day training program of the Mathematics Education Council. After that inspiration, I made efforts to learn by connecting technology. Now, technology and the teaching profession have become complementary

In this way, the use of ICT was found to be very low until some time ago. With the development of modern technology, the use of ICT tools in the education sector can be found to be progressing rapidly.

Sakula's Stories about Using ICT Tools

I approved Sakula (pseudo name) to be my research participant and collected his stories concerning family and educational background. Also, I collected stories concerning learning and teaching profession, particularly about using ICT tools in teaching mathematics. After getting ready for the interview with interview questions based on research questions, I approached Sakula. She met the criteria of being a research participant in my study that I had set for my research. I conducted interviews first and second in face-to-face mode. I conducted the third round using the online Zoom conferencing tool, and recorded the audio and video conversation for the evidence.

Sakula was a resident of Bharatpur, Chitwan. She was the mother of two children, both of whom were sons. She had passed her SLC from Gyan Jyoti Secondary School, Gorkha. It was an old established school in the locality. She had completed her intermediate level at Saptagandaki Campus with a major in mathematics. She had graduated from Saptagandaki Campus in Chitawan, with a major in Mathematics. She had been teaching mathematics since 2066 BS at the secondary level. She was a member of the Math Council, Chitawan and a member of the Society of Technology Friendly Teachers, and Mathematic Subject Committee, Nepal.

During the conversation, I asked Sakula- what kinds of ICT tools do you remember being used in your school life when you were a student? In this question, Sakula narrated her experience as follows:

I don't remember much use of ICT in student life. Gyanjyoti Secondary School in Gorkha District was a remote place. Even a calculator tape recorder was not available. At that time, we used to rely entirely on books and teachers. I started to use ICT tools only after SLC.I have the experience that even the listening test at SLC level was read orally by the teacher. Since Radio Nepal was a reliable means of communication at that time, we would learn through the radio.

Figure 3: Old Radio

I started my teaching profession at the primary level and started teaching at the secondary level in the year 2066. After starting the teaching profession, I began to use the dictionary to look up the word meaning. Also, I used math dictionary, and mobile phone to search for pictures. I began using a PowerPoint presentation in class while teaching.

It is clear from this story that the education sector of Nepal is far behind in the field of technology. Education can only be achieved through literacy. It is clear that the current manpower has not been able to shift from old education system. Education should be advanced according to the changing times. It seems that ICT tools should be used in teaching and learning activities.

Rudra's Stories About Using ICT Tools

I decided Rudra (Pseudo name) to be my research participant and collected his stories concerning family and educational background, teaching and teacher profession, and using ICT tools in teaching mathematics. After getting ready for the interview with interview questions based on research questions, I approached Rudra

and decided to have him as my research participant. He met the criteria of being a research participant in my study that I had set for my research. I conducted interviews, first and second in face-to-face mode, and the third round using a mobile tool. I recorded the audio conversation for the evidence.

Rudra was a resident of the Suklagandaki Municipality of Tanahun. He was the father of two children, one a daughter and the other a son. He had passed his SLC from Siddhartha Secondary School, Bhimad, Tanahun. He had completed PCL level from Prithivi Narayan Campus in Pokhara, Kaski, with majors in math, Nepali, and economics.He had passed the bachelor's level from Prithivi Narayan Campus, Pokhara, Kaski, with a major in mathematics. He had received his M.Ed in Mathematics Education from Tribhuvan University's Central Campus in Kirtipur. He had been teaching mathematics for fourteen years since 2066 BS. Rudra was the Mathematics Teacher and Coordinator of the Mathematics Subject Committee at Panchamuni Dev Secondary School, Suklagandaki Municipality, Tanahun. He was also a general member of the Math Council and the Society of Technology Friendly Teachers Nepal.

During the conversation, I asked- what kind of ICT tools do you remember being used in your school life when you were a student? In this question, Rudra narrated his experience as follows:

> *When I was studying at school level, ICT tools were not used much at that time. The use of ICT in the school was limited to a scientific calculator and a tape recorder, and nothing else was used. We used Radio Nepal and to listen children's programs, adult education programs, folk songs, and news.*

Rudra started teaching at the lower secondary level at Pokhara Academy, Pokhara. He started teaching using tape recorder at the ANFA Academy in

Kathmandu at the secondary level. After completing his master's degree, he taught at Bhimad Public Secondary School in Bhimad Municipality and started his government service at Shree Krishna Secondary School, Gajarkot, Tanahun. After that, he was transferred to Shree Chhabdi Secondary School. Currently, he was working at Panchamunidev Secondary School in Shuklagandaki Municipality. In the question- at what point did you start the use of ICT? - Rudra expresses his experience as follows:

> *When I was teaching in a boarding school in Bhimad municipality, whenever I encountered problem, I used to ask with friends. My friends used to remind me to do a google search and this was how I started using the internet for teaching and learning. In M.Ed., there was a course ICT in mathematics. It included topics like SPSS, PowerPoint slides, word fermenting, email and the internet. At the same time, I got a loan and bought a computer, which helped me learn more about computers.*
>
> *After that, I went to a remote place for a job. So, I was not able to use it much. When I entered Panchamunidev Secondary School, some technical things started to operate. While studying in Kathmandu, I learned to be ahead of the curve in typing and drawing figures.*

Looking at the personal stories of the participants, it seems that they did not get to use ICT tools while they were studying in their student life. Even after starting the teaching work, ICT was not used much until COVID-19started. ICT tools were used after alternative teaching started. It can be seen that COVID-19 has created opportunities to use ICT tools.

Participant's Personal Experience Using ICT Tools for Mathematics Learning

Under this, the participants' personal experiences of using ICT tools are mentioned. The experiences of the participants during ICT learning and the ICT tools they used during mathematics teaching and learning are presented here.

Ashil's Experience for Using ICT Tools

Ashil expressed his experiences of using ICT tools while advancing teaching-learning activities:

> *It was around* 2069-*2070 BS. One day, when Shree Prasad Ghimire came from Kathmandu Tahachal campus as an observer to the campus, I said something to him. I said, 'I have GeoGebra software, but I don't know how to use it properly.' During the day, I learned something. After that, I used GeoGebra in class. I began taking the projector to the class, bring the laptop, connect the power line and connect everything, display the GeoGebra in the class and show the triangle by using Angles, Sides, and Vertices. When showing the points, the students used to look excitedly and consider it very interesting. I also felt like I was teaching in a new way and GeoGebra was introduced in teaching.*
>
> *In* 2071-*2072 BS, the Mathematics Council organized GeoGebra training in Kathmandu. In which Bed Prasad Dhakal gave training. The participation fee for the program was only* 6000. *At that time, GeoGebra could be used well only after spending three days in Kathmandu and learning by paying personal money. After that, while teaching other friends, I was able to easily bring GeoGebra to the classroom.*

He shared his experience of using GeoGebra. Apart from this, what other tools did he use in teaching? Ashil shared his experience like this:

When the development of the internet became universal after 2071-*2072 BS, school, campus and homes were connected. We searched other online tools. In this connection, we studied Mathematica software in the second semester of MPhil.*

Recently, when the lockdown started, I got the opportunity to participate in many trainings. From which there was an opportunity to learn and teach. It was done using PowerPoint, Word, Excel etc. Mathematics subject had to be presented step-by-step, and because it was not easy for that, it could not be brought to the classroom. The most important thing in the classroom is classroom management. If there is no good equipment in the classroom, then the classroom cannot be managed properly. All the materials had to be carried and taken off, so they could not be used all the time. It could not be used easily.

At present, there has been some ease since all the materials, including the projector, smart board, smart TV, and computer are available in the classrooms. Now, it is possible to prepare high-level content from mobile and show it by mirroring. It has become even faster and easier. Even when students' homework is to be checked, it is possible to check everyone's homework at the same time by taking a photo of the student's homework and displaying it to everyone while discussing it.

Materials shared on social media can be used in class immediately. How many mobile apps can be used in class teaching? The contents of the website can be used on display and can also be used interactively if there is an internet connection. For example, PHET simulation is a suitable example of this. It has also made teaching easier.

Ashil shared how he felt when he came from yesterday's situation of not even being able to use the old calculator to today's modern technology era:

> *In school life, we were not even being able to use a calculator. If we could have used technology in an accessible way from that time, the world view would have been different. At that time, the view was like that of a 'Kuwa ko Bhyaguto'. It seems that if all the modern technologies had been accessible on time, then the teaching profession and the art of teaching could have progressed a lot.*

What is clear from this story is that the time is changing, and teachers should also change according to time. If teachers are not updated according to time, it is not possible to change in education. The use of ICT tools has brought a change in thinking as well as a change in behavior. If we want to compete in international education and produce skilled labor, we must change education and teaching skills with the times. Learning should be promoted by individual initiative rather than by what all governments do. If ICT tools can be used in mathematics, mathematical concepts can be learned easily in a modern way.

Bigal's Experience Using ICT Tools

Many efforts have been made regarding the use of ICT in mathematics. Institutional, governmental, and non-governmental organizations have also been creating opportunities for learning. Bigal's early experience of using ICT tools and creating a learning environment is as follows:

> *It must be said that COVID-19 has created an opportunity. After COVID-19, there was a provision to operate ICT tools and alternative teaching for many teachers. Many mathematics trainings were conducted on an ICT basis. From GeoGebra to thirty-three day's training, eighteen days of training, the*

> *Mathematics Education Council's training as well as the training program taught by the Education Training Center provided significant support to general teachers in ICT-related learning. The files prepared have been used in teaching and learning. Currently, many teachers, including me, are teaching using files prepared in the group.*

While working in the field of ICT, there are many memorable events. The teaching profession itself is a respected profession. After entering the teaching profession, among the important works in the field of ICT, Bigal's memorable events are as follows:

> *I am the member secretary of the Society of Technology Friendly Teachers (STFT) at Central Mathematics Department. The organization conducted an online GeoGebra learning program at home every evening from* 8 *pm during COVID*-19. *In that program, I conducted the program as a program teacher. After that, the Department of Mathematics conducted free training for basic to advanced courses in GeoGebra by placing more than one thousand mathematics teachers at one time. Because of that training, there was a stir in mathematics teaching and now many teachers around the country teach using GeoGebra. Therefore, I have taken this as one of the most important and memorable activities I have done in the field of ICT in my life.*

Regarding the use of ICT, Bigal says, *In the next few years, every school will conduct teaching and learning activities using ICT. At present, ICT is being used in institutional schools, now gradually it will be mandatory to use it in public schools as well.* If technology is used in teaching and learning, children get more support and ease in clarifying the content, along with personal monitoring. It has also helped to

improve the relationship with the teacher. Bigal's thoughts on using and not using ICT tools were:

> *If we compare the context of when we were studying before and when we are currently teaching, it is clear that the context of using ICT and not using it is the same. Earlier, I could not experience many ICT tools, but now they are used for teaching. Not using ICT tools means only following the old method, but using ICT means teaching by mixing with modern methods. In terms of the ease of use of ICT tools, the use of ICT tools is now mandatory, not only in practice. If we don't use ICT tools, we will definitely fall behind. For example, currently a new curriculum has been implemented but the hardcopy is not available on the market. You have to use the website to check it out. There is no time to go to the library and search for books like before. The environment of buying books has also changed. By doing a Google search online, we can now search which document says what. Using modern technology in teaching has become mandatory. Without ICT, current teaching is incomplete.*

Bigal shared a recent event worth remembering while using ICT:

> *During the time of COVID*-19, *I connected with students and conducted classes through the Zoom conferencing tool and got a new experience of giving and viewing homework and evaluating it using Google Classroom. I have taken it as a very new experience and an unforgettable time. It was fun while learning and teaching. At that time, we also shared some files through Messenger. This was probably my first experience of teaching at home.*

In this way, when using ICT, it is not always possible to use ICT in mathematics due to the need to complete the course on time. However, by presenting the main topics in the course of teaching, teaching the students to search for and use

something, and providing files through various means, the students get ease in learning. Bigal's experience is that every teacher should take the path of using ICT in the current modern times.

Sakula's Experience Using ICT Tools

Sakula's experience of using ICT was as follows:

> *One day, I went to the program of the Math Council. A PowerPoint presentation, Mathematica software, and GeoGebra were used in the program. My first experience of using ICT tools comes to mind. First of all, Ramesh Khanal used cryptography in the program of the Math Council of Chitwan, which was used to visualize through coding. Earlier, in the US, the army used to exchange messages by coding them so that others could not understand them through cryptography.*
>
> *In COVID-19, the use of ICT tools increased in schools, in which various tools were used. Until now, the above tools have been used. In particular, Power Point presentations, open boards, GeoGebra, smart boards, mobile phones, smart TVs, math apps, websites, etc. have been used. When using ICT, figures can be shown easily. Many topics can be presented by saving time. Hundreds of problems can be created automatically from a problem model that becomes a figure after putting in equations. Compared to the previous method, using ICT is easier. I have experienced it.*

Sakula shared her experience of using ICT tools during the current COVID-19 as follows:

> *Covid-19 proved an opportunity to use educational ICT. Before COVID-19, ICT tools were used very little in the education sector. After schools were closed for a long time, online education started in the world as an alternative*

solution. Accordingly, the government of Nepal started the use of technology as an alternative learning tool, but the training of teachers and access to technology were not expanded. Although the program started, preparation is not very effective. Those who have access can find that they can make full use of the opportunity.

To summarize the above, the Math Council and STFT have been providing opportunities for teacher training to increase mathematical ability in Nepal. At present, GeoGebra, PowerPoint presentations, open boards, smart boards, math applications, math mobile apps, and websites have played important role in mathematics. Covid-19 created an opportunity to use technology in teaching and learning activities.

When asked about the memorable event of using ICT, Sakula shared her important event as follows:

The event where the math teacher learned GeoGebra in the training given by CIDO was an important event. The 5-day training of the math council gave the math teacher more motivation to enter the field of ICT. After that, when I joined STFT, I got the opportunity to do ICT and math-related learning with teachers from all over Nepal for about 5-6 months in the evening. I had the opportunity to meet many friends and share knowledge. This was taken as an opportunity given by COVID-19 and was a very unforgettable event. At that time, when teachers had to stay alone at home, in a monotonous situation, there was an opportunity for learning.

During the lockdown of COVID-19, there was a 33-day program organized by the STFT math subject committee. I took responsibility as a group leader, and while fulfilling this responsibility, I got the opportunity to explore and learn

many things. During the presentation among more than a thousand teachers, I felt proud that I had done something in the field of ICT. It motivated me to do more.

GeoGebra's training STFT conducted a program to teach long-term basic and advanced courses during the lockdown. He continued to learn even in the evening for5-6 months. It can be found that the 33-day program held by STFT provided important contributions and support to Nepali mathematics teachers to learn GeoGebra and teach mathematics through GeoGebra. Currently, many teachers have started using GeoGebra in mathematics teaching.

Rudra's Experience Using ICT Tools

During the conversation, I asked one question: how have you been learning and using ICT tools? Rudra narrated his experience in this context:

I remember seeing Bed Prasad Dhakal Sir using Microsoft Math. He inspired me to use such things. When the COVID-19 lockdown started, it was necessary to re-learn the things that were forgotten. It was an opportunity to learn creating PowerPoint presentations, searching for math websites, using math apps for typing, and also creating content and conducting online classes through Zoom conferencing. GeoGebra was used the most during this process. Other tools such as projectors, laptops, smart boards, smart TVs, mobile phones, desktop computers etc. were also used.

Students are very forward in technology. Students seem to be ahead of teachers in the field of technology. Therefore, students are also happy to study using ICT tools. Previously, while teaching math problems, if we could not solve them, we had to say that we would do it the next day, but now, we search for the solution. Therefore, the use of ICT has become very easy and effective.

How much do you think ICT tools have helped in the teaching profession in the past through Khari-chalk-marker-projector? Regarding the question, Rudra said:

> *ICT has made it very helpful and simple. It is necessary to create a mechanism to provide theoretical and practical knowledge. In the world market, Nepalis far ahead in mathematical learning because they work hard. I think that Nepali people would be far ahead in the world market if we teach our students by connecting them with technology and providing corresponding mathematical knowledge.*

From the above discussion, it is clear that, although the use of ICT tools has been around for a long time, it has been revived to a large extent after the COVID-19 pandemic. At that time, online education got priority. At the same time, ICT tools were also used during mathematics teaching. Teachers are increasing the use of ICT tools because the use of technology is indispensable for alternative learning, and for that, ICT tools have to be used. They use it to learn things they don't know and use them in teaching work in school as well.

In mathematics, GeoGebra is used as a dynamic software. Other tools are used to support it. Therefore, in the experience of the participants, ICT tools have helped in learning mathematics. Its use has created simplicity and ease and has become very useful for teaching mathematical content to students. Therefore, the participants stressed that, in the future, an environment should be created to bring it into regular use by providing resources and opportunities for necessary training.

Student's Reflection About Using ICT Tools After Teaching Mathematics

In the context of teaching, when the teacher conducts the class using ICT tools, the students show different reactions in relation to the class teaching. The

responses expressed by the teachers after teaching through ICT have been taken as reflection.

Reflection involves analyzing our own learning and teaching practices. It can contribute to effective pedagogy, which is one of the key components of an effective curriculum. Reflection is the process of exploring and examining oneself, one's perspectives, characteristics, experiences, and behaviors and interactions. Gaining insight and understanding of how to move forward, reflections are often made in writing. Reflection can be questioned and developed more thoughtfully. Reflection brings learning to life. Reflective exercises help learners find relevance and meaning in lessons and make connections between educational experiences and real-life situations. enhance insight and pave the way for future learning. Critically reflective teachers are able to challenge assumptions and develop new perspectives to understand complex aspects of culture and classrooms. You have to reflect cognitively.

Regarding the use of ICT, the feedback of the students also gives information about how the teacher can advance ICT in the future. Regarding students' feedback on ICT use in mathematics teaching, Bigal says:

> *I have received a good response from the student about ICT tools. Children enjoy reading using ICT tools. They also get the opportunity to do self-practice. But it is not always possible. Since there is a lot of subject matter and the course has to be completed on time, it seems to be a bit difficult to cover the course.*

In the interview period, I asked one question: how have you received feedback from students while using ICT tools? Ashil said:

> *These days, students like to use digital tools from an early age. So, how can they use ICT tools when they have the same experience at home? They even try to use and experience the presentation of the teachers while using ICT tools. They like to learn in a fun and easy way.*

Regarding feedback from students after using ICT, Sakula says:

> *When using ICT tools, students listen with a little attention. Many things can be taught in a short time. Usually in construction, geometrical figures can be clearly shown. Geometrical proof can be shown and verified in a simple way. Not everything can be presented in the classroom. Even so, they try to find out and learn by themselves. I feel that the students easily grasp the content because of the ease in these matters. Because of this, I understand that ICT tools are easy and effective for students.*

What is clear from this is that after using ICT, the students listen to, watch, and use the content of mathematics with interest. It helps in their conceptual development. ICT tools can be used in every mathematical activity, but it is considered suitable when the teacher carefully presents only the topics that he is comfortable with in the class. All students in the class are not of the same nature and ability. It is necessary to understand the diversity of classes and use ICT tools. Rudra's experience in this regard is as follows:

> *What I found is that some of the sharpest students in the class are very happy while teaching using ICT tools. They become a means of teaching even the weakest students. Even average students can find learning easy. Weak students are not interested and do not want to play with ICT. Students who are interested in learning mathematics are found easier to teach mathematics using ICT tools.*

In conclusion, it seems that using ICT tools in mathematics helps the students to learn in a fun environment, be able to practice on their own, be able to understand mathematical problems easily, learn by focusing on listening, watching, and doing. In addition to this, it can be obtained from the experience of the participants that ICT tools help to create mathematical pictures, to do participatory teaching to students who know and do not know the subject matter, and to easily grasp the subject matter.

Stakeholders' Support to use ICT tools for Mathematics Learning

To bring ICT to the classroom, it is necessary to get support from many stakeholders. It is not possible to use ICT in education without the support of stakeholders. An attempt has been made here to present the response given by the participants to the question- what kind of support students, teachers, schools, and other parties have provided while using ICT？ How much support ICT tools have provided in mathematics learning and how ICT tools help students, teachers, and mathematics learning?

Student's Support for Using ICT Tools

Ashil's experience in teaching mathematics using ICT tools and supporting students in mathematical learning is thoughtful. He said:

> *The use of new technology is revolutionizing schools. For this reason, it is also necessary for students. But it is very important for teachers and students to know everything about this field. Students are very enthusiastic. They want to learn through technologies. The new technologies of information and knowledge are those which are abbreviated as ICT. ICT has started to be a basic part of the school curriculum. If students want to do something to change society, it is necessary to have knowledge of new technologies.*

All students are excited to use ICT tools. If the teacher has used it, then in that case, the students should use as well. All the participants had one opinion in this regard. According to them:

> *Not all students have their own devices. Internet facilities are not available at home. However, they try to learn using their parents' devices at home. As they have to learn according to the demands of modern times, they learn enthusiastically. The students may also help the teachers in the process of teaching.*

School's Support for Using ICT Tools

Regarding the use of ICT, schools and school management committees have also tried to help as much as possible. Even though they want to help each other, they are not able to do so. The main reason for that is economic management. Only if the school works in the field of ICT, the teacher may use ICT tools. Therefore, the school has an important role in making mathematics teaching effective, in which ICT tools help. Regarding the use of ICT tools, the school administration's approach may also be different. In this study too, it is found that the responses of the participants were different when asked how much support the school has provided regarding the use of ICT. In this context, Ashil says:

> *The school has to support the interests and achievements of the students. The school administration is also supporting them. At school, we used to use projectors for projection. In the meantime, the school has moved ahead by using smart TVs that can be used more for audio-visual purposes than projectors. In this regard, the school has helped all our subject teachers to teach the classroom using digital tools. Through direct screen mirroring of mobile phones on smart TVs, we have taken everything forward through the*

mobile learning process because every teacher has a smart phone in his hand. The work of showing through mobile, discussing, interacting, and helping to establish the concept is being done through technology.

If ICT tools can be used properly, the learning of mathematics can also be meaningfully advanced. Now Nepal's government has introduced many ICT-related programs in schools as well. State governments and local governments have also invested in the field of technology. Whether or not the ICT tools provided by the school are used correctly is in the hands of the teacher. Regarding the availability and support of ICT tools, Sakula's and Rudra's response were common:

Our school is a model school declared by the government of Nepal. Regarding ICT, our school has distributed one laptop to all the teachers. Special arrangements have also been made for subject committees, including training. There is an arrangement of projectors in the classes. Smart boards are available in some rooms. The school is also encouraging us to use ICT as much as possible and supporting us as needed. If we want to use it, there is an environment where we can enjoy teaching using ICT tools.

Not all public schools in Nepal are able to use ICT tools. Some schools don't even have electricity, so let's not imagine ICT there. Most of the students studying in public schools are not financially stable, they are not in a position to buy a device, and they do not even have access to the internet. In such a situation, there are many schools in Nepal where the school administration could not provide even if they wanted to. In this context, Bigal says:

Now the environment of this community school is a little different. It seems to be affected by the regional location and the income level of parents, as well as other things. It is true that the school administration could not do what it

wanted due to a lack of budget. With some efforts from various organizations, including the government of Nepal and local level metropolitan government, we have managed some of them, including the e-library and projector. However, its use in teaching and learning is not being done effectively. We plan to take more initiatives in the coming days. The administration is also providing all possible assistance.

In general, as long as there are resources in the school, ICT is given priority. It seems that teachers should increase their capacity and take the initiative to bring the available ICT tools to the classroom. It is clear that the learning level of mathematics also increases when ICT tools are used correctly in mathematics.

ICT Tools Support for Mathematics Learning

The opinion of the participants regarding the support of ICT in mathematics learning is mixed. In Ashil's opinion, *ICT* helps students to learn math easily. Similarly, Rudra's thoughts in this regard are as follows:

I think that the use of ICT is good and effective not only in mathematics, but in all areas of learning. In the next era, mathematics should be taught along with ICT. Mathematics is considered a complex subject. If we use it as a means to present the content and transfer it, it helps to give conceptual learning that can be taught to others.

For this reason, teachers should also be up-to-date, and students need to have more ability than teachers. We should be able to expand the field of their abilities and provide them with a learning environment related to mathematics. For example, we can do this work by making them search Google and showing them videos. In some cases, while we solve the problem, some challenging questions come up. If those questions cannot be solved by

us, we should also do it with the help of ICT. I have already informed everyone about this.

Mathematics learning cannot be effective by teaching in one way. If teaching can be done in different ways through the use of ICT, the students will have conceptual learning towards the subject matter. Sakula's opinion in this regard is as follows:

It has helped in things like critical thinking, and logical reasoning of students for learning ability. For example, earlier, when factorization of algebra was taught, only one method was used, but now algebra tiles are used. If you give some ideas to the students, they will find and learn by themselves, find new ideas, learn them and present them. It can be found that students are motivated towards mathematics learning when they use ICT. At present, the availability of smart phones in the homes of most students has also helped in learning.

In the course of the interview, I added a story. Everyone was of the opinion that ICT should be used. It was also the demand of the time. Recently, ICT has started to be used in mathematics learning. During this conversation, I asked a question to Bigal: Do ICT tools help in learning mathematics? His answer in this context was as follows:

Why not, sir? In terms of teaching mathematics, I am also an ICT-related trainer. As an expert in the Mathematics Subject Committee in Bharatpur Metropolitan City, I also conducted numerous trainings. What I have noticed while doing the training is that the math teachers are not able to use computers in the ICT and some of them do not want to. Another thing is that the concept of ICT is not well understood and the mentality that the extra child

goes to the classroom and the course cannot be completed on time seems to have a little more effect. To make it a little more effective, if we can take the concept of learning by doing through ICT from the lower level, then the same kind of environment is being created in the upper class. I think that in the future, it will be easier to conduct classes on an ICT basis and the classes will also be effective.

In my opinion, the educational institutions of Nepal have been trying to play an important role in the promotion and development of ICT tools for mathematics learning. This effort can be found to have played an important role in improving the teaching and learning process. ICT tools have played a supportive role for teachers and students in teaching mathematics and guiding them through its use.

ICT tools enable teachers to use pictorial, video, and animation materials created from ICT tools to solve mathematical concepts and problems. Open mathematics apps like GeoGebra help teachers find easy and interesting ways to teach these difficult math subjects. Bigal continued:

For example, some powerful 3D applications allow the manipulation of solid geometric figures such as cones and cubes, thus, enhancing student comprehension. Using these ICT tools make it easier for students to understand and increase their motivation to learn mathematics content. Teachers, on the other hand, are stimulated with the aid of using the effective outcomes in their students' learning.

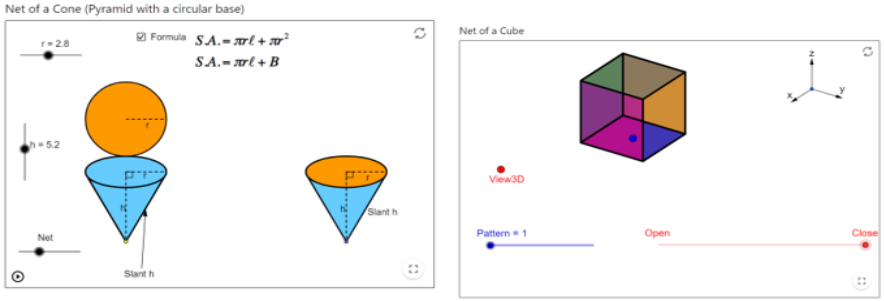

Figure 4: Model of Cone and 3D Picture

It seems, ICT tools provide six main ways for students to learn mathematics. First, it is learning from feedback. ICT tools can provide fast, reliable feedback without judgment or bias. This increases students'` confidence and helps them develop their own ideas. Second, it is observing the pattern. The speed of ICT tools allows students to provide many examples when investigating math problems. Third, it is looking at the connections. ICT tools make it easy to link formulas, tables, numbers, and graphics. The results of seeing one representation change over another help student understand the connections between them. Fourth, it is dynamic image manipulation. Students are encouraged to use their computers to manipulate figures and visualize geometry. Fifth, information research ICT tools allow students to work with real-world information that can be displayed in a variety of ways. This strengthens its interpretation and testing. Sixth, it is learning to use ICT tools. When the student creates a calculation for his/her ICT tool to perform a specific task, the student is asked to verbalize the commands within the problem-solving system.

Zakaria and Khalid (2016) stated that "the benefits of applying ICT tools in teaching mathematics are: it attracts students' interest in learning mathematics; it increases their motivation and performance; it encourages lifelong learning; and it facilitates positive interactions and relationships" (p. 56). ICT tools offer dynamic opportunities for teaching in the mathematics classroom. It improves the learning process and brings concepts to life through a variety of engaging and interactive media tools. We can also meet the needs of every math learner and provide additional support to create a customized learning experience.

Overall, ICT tools have increased the ability of students in every aspect. Therefore, if ICT can be used in mathematics, it seems that it will increase the

mathematical knowledge, skills, and abilities of the students as well as the overall learning level.

Positive Impact of ICT tools on Teaching and Learning

Regarding the role played by ICT in the learning ability of students, I asked Rudra about his experience. What difference did you find in the learning levels of students when using ICT compared to those who were not using it? When asked, his response was as follows:

> *This is how I saw it before. Students who sometimes feel bored while doing math in class can go to play in other subjects like health. They can enjoy themselves by listening to stories and poems in Nepali. They can learn about various social subjects by making jokes. But, in mathematics they have to learn only by solving problems. For these reasons, teaching mathematics has not been so easy. However, using ICT helps to create a learning environment by increasing the interest of students in every way. In the future, building a math lab in the school, in which ICT is also connected is a good idea. Through it, an enabling environment for learning mathematics should be created. Looking at how mathematics has been taken in the world market, using various software or apps through audio-video, and moving forward with technology is possible, only if mathematics is taught to make mathematics practically easy and fun. Otherwise, if we go with the old method, it is not so easy to get the mathematics into the students' brains. The same subject can be taught in many ways in the classroom. By teaching in one way, the class takes 45 minutes. But, if 5-5 minutes' videos are presented, students get the opportunity to learn many ways from one class. It is easy to tell them to take*

the things learned at home and to make them practice. But it has been my experience that weak students are not interested in ICT.

In my opinion, the use of ICT can serve as a motivation for teachers due to the positive results obtained. ICT tools lead to more effective teaching and improved student achievement. These positive results keep teachers motivated in their work. Research shows that some teachers initially resist using ICT tools to teach mathematics, but these resistances are short-lived (Mkomange et al., 2012). When students perform well, teachers' beliefs and attitudes change. This brings changes in the teacher's teaching skills and practice. Therefore, it can be considered useful to incorporate ICT tools for proper conceptual learning of mathematics.

Jurdak (2004) states that ICT tools enable teachers to use simulations to better develop specific mathematical concepts. Here is an example presented by Alish:

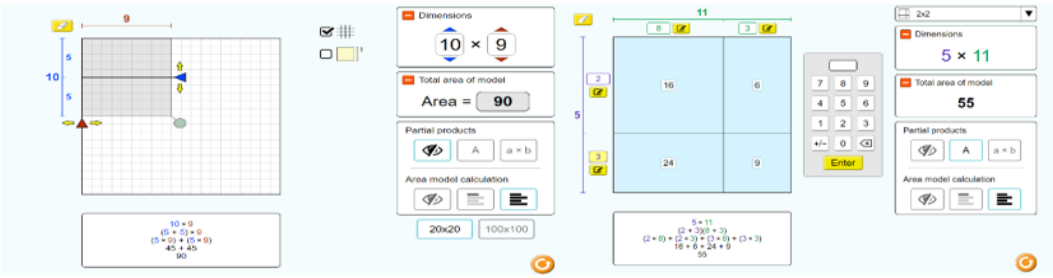

Figure 5: GeoGebra Model of Area

While teaching algebra, presenting the area model, first extract the area based on length and width based on a single unit from the 'Explore Tab' ,which is shown in the first figure.

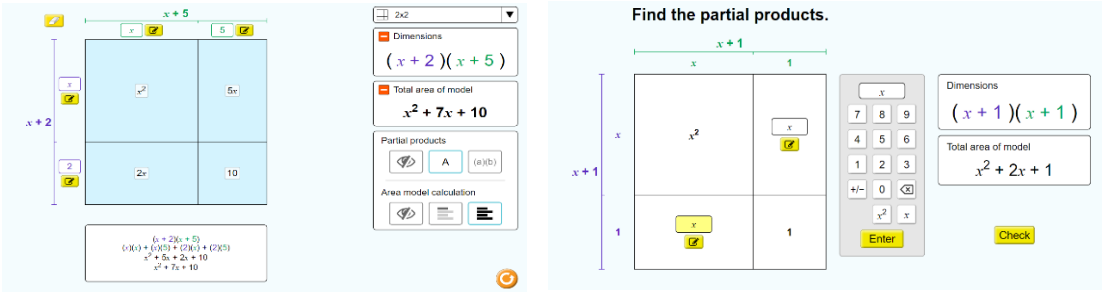

Figure 6: Model of Factorization

Next model, find the area using 'Generic Tab' and keep the number format in length and width. Example: In binomial-to-binomial multiplication, (8 ×3) (2 ×3) = 11× 5 = 55 units, which is shown in the above figure. For the next step of learning, place the variable in the ‘Variables Tab’. For example, place (x+5) and (x+2) in length and width. The solution also occurred instantly, which is shown in the above first figure. Finally, enjoy the game related to the above concept from ‘Game Tab’, which is also shown in the above figure.

What is clear from this model is that students can learn the formula of area from Algebra's area model: A = l × b unit and multiplication of variables from length and width as well as the concept of area. So, it is clear that if an ICT tool is used, many mathematical concepts can be simplified, even from the same model.

ICT improves students’ learning by facilitating interactions among students. ICT devices encourage understudies to share their bits of knowledge and take an interest in discourses on different subjects. The key concept is that ICT encourages intuitive learning among students without educator’s supervision. Utilizing collaboration successfully to illuminate issues is one of the key lessons that teachers need to pass on to their practices. Collaboration plays a vital part in most work situations. Therefore, when ideas such as collaboration are emphasized, a student's teaching experience is enriched by her use of ICT.

ICT encourages to bolt in a preparation of trial and error in learning. Fuglestad (2011) shows that ICT tools encourage students to experiment and arrive at solutions of the problems. In this way, ICT encourages students to seek answers and become independent. This increases self-efficacy, a desired trait in students. The use of ICT increases students' interest in subjects. In this way, students' interests in learning are

awakened and sustained. Increased interest is a desirable trait because it leads to a better understanding of the mathematics content.

Students study using portable devices such as laptops, tablets, and mobile devices. Therefore, they can do educational work with them outside the classroom environment. ICT enables students to participate in ongoing knowledge construction when using portable devices outside of the classroom (Niess, 2005). Doing so, students can interact with the subject outside the classroom to develop their understanding of mathematics concepts.

It is not only that ICT tools help in mathematics learning, but also how to use them effectively should be taken into consideration. Ashil's views on the effective use of ICT tools are:

> *The students do not find it fun when they do not use ICT tools. When ICT is not used, they tend to lean towards learning as before. So, ICT tools have become very necessary, and it has become necessary to bring them into pedagogy. To bring the class into real interaction and for concept making, ICT tools have become mandatory. It makes math fun and attractive.*

ICT tools help develop positive attitudes towards learning and teaching mathematics. Most school students in Nepal find mathematics a difficult subject. Similarly, they have a negative attitude towards mathematics, which leads to poor results. The use of ICT tools in the classroom helps in developing more positive attitudes, especially for underperforming students. Pierce and Ball (2009) found that "most students improved their attitudes towards learning mathematics when exposed to ICT. This is due to the personal enjoyment that students derive from using computers. ICT promotes a deeper understanding of mathematical concepts and rules" (p. 42).

ICT Tools Help the Problem-Solving Skills in Mathematics Learning

Problem solving skills are considered important in mathematics. It is being discussed here in the context of how much ICT tools help in solving problems while doing mathematics learning.

Narrating his experience with problem-solving, Sakula says:

> *Some changes can be seen in problem solving when using ICT. Previously, teachers only used the methods taught in books, but when ICT is used, many ways of learning are explored. So, it has also brought about a change in the way students learn. How many problems can students find and solve by themselves using ICT? Therefore, it can be seen that ICT has important support in problem solving.*

It explains how to identify and define math problems. Participants encouraged to use ICT tools to make consistent decisions, methods, information, and models; Create, extend, and adjust modern methods; use clean cuts with modern settings; and evaluate the reasonableness and accuracy of the arrangement. Problem-solving situations require learners to combine all the numerical information of concepts, strategies, thinking, and communication skills to solve problems.

Some literature states that using ICT to teach mathematics improves the ability of teachers to teach students to solve problems. ICT supports teachers in constructing realistic and complicated classroom management strategies. These difficulties are modeled after real-life difficulties students might encounter. Thus, through problem solving, mathematics creates a context that simulates the actual lifecycle. Problem-solving is a necessary part of all science learning, and teachers should encourage undergraduate programs to develop basic skills for problem-solving throughout the subject of mathematics (Mkomange et al., 2012).

From the above discussion, I have found that problem solving requires creative skills, critical thinking, and the ability to put ideas and theories into practice. Additionally, interactive and self-directed problem-solving experiences motivate students. This is expressed through the development of students' cognitive skills such as self-monitoring and self-reinforcement.

Conceptual Understanding Vs Procedural Knowledge

About conceptual learning, Ashil argues that: *A concept is something that is only expressed in words, which is expressed only in feelings. Feelings are exercised and stimulated by ICT tools. Therefore, ICT tools are very useful as they help to clarify the concept.*

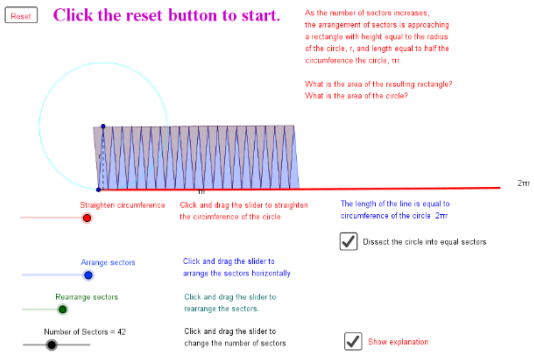

Figure 7: GeoGebra Model of Circle Area

Ashil presented an example to illustrate his point: *When proving the formula for extracting the area of a circle by visualizing it, students can clearly understand the concepts related to the construction of the formula and feel comfortable on it.*

The secondary level curriculum had not included experimental work and project work in mathematics. But the current new curriculum has included it. Bigal said that in that environment, the old problem-solving method, which was based on procedural knowledge, would be replaced by ICT tools for conceptual understanding:

> *Rather than this individual effort, it seems that all teachers should make an effort in the country as a whole. The current new curriculum has reduced the old method to a practical base. It can be seen that there is a need to think about it as the subject matter through project work create an environment*

where students can learn easily and the old mindset towards learning mathematics changes.

Rudra's view on how much ICT tools help in conceptual understanding is as follows:

Certainly, ICT has helped for conceptual understanding. Our learning is momentary. After some time, if we are given the same problem again, we will not be able to do it. This practice is not able to sustain learning. Problem-solving methods may help in immediate learning for exams but cannot teach students to develop their understanding of the content through long-term memorization. Therefore, it is necessary to use ICT for conceptual learning. For example, we teach subjects related to home arithmetic in Class 9, where we can teach how to pay electricity bills through an app using a mobile phone. In the same way, if we teach to pay the water bill using the technology, it helps to solve the practical problems. From this, one can also get information about things like fines or discounts for paying the water or electricity bills. If we can teach using technology in this way, practical knowledge will be acquired, and mathematics can become simple and meaningful as it helps to solve practical problems. In this way, it can be said that ICT has a positive effect on mathematics education.

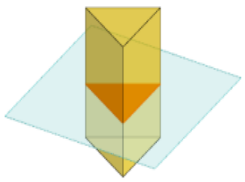

Figure 8 : GeoGebra Model of Prism

Looking at it this way, what can be concluded is that to be mathematically proficient, a student must have conceptual understanding and

procedural fluency. Therefore, for the present as well as for the future, it is necessary to develop conceptual understanding in students by making maximum use of ICT tools for mathematical learning. The following is an example of conceptual understanding of prism:

> *When giving the concept of Prism, it should be shown that the cross-section areas are congruent with the parallel surface and that the cross section areas are congruent with the base face. When making that model, we cannot show it with solid materials. While keeping it in 3D from GeoGebra, it is possible to show the surface to easily give the concept of cutting any type of Prism. The real concept that makes learning attractive to students can be strengthened by the dynamic thing. Since it can be applied in this way, ICT tools are very important in mathematics teaching. Even abstract things can be visualized by making them dynamic, which can make the concept clear.*

The discussion above stressed that the students demonstrate a conceptual understanding of mathematics when they demonstrate the ability to identify, name, and create examples of concepts. They can use and link different representations of models, diagrams, operations, and concepts. They can identify and apply principles, learn and apply facts and definitions, compare and integrate related concepts and theories. Also, they can recognize, interpret and apply symbols and terms used to represent concepts. Conceptual understanding reflects a student's ability to reason in situations where he or she carefully applies conceptual definitions, relationships, or expressions.

Students demonstrate procedural knowledge of mathematics through the correct selection and application of appropriate procedures. Concrete models or

symbolic methods are used to confirm or justify the correctness of the procedure. It expands or modify procedures to address the underlying factors of problem attitude. Procedural knowledge includes the ability to read and create graphs and tables, the ability to perform geometric constructions, and the ability to perform non-calculus skills such as rounding and ordering. Procedural information frequently reflects a student's capacity to relate the method of a calculation to a specific issue circumstance, to apply that calculation accurately, and to communicate the results of the calculation within the setting of the issue.

Method of Teaching Mathematics Using ICT Tools

Teachers use many teaching methods during the instruction. The current need is to gradually reduce the ancient teaching methods and adopt student-centered teaching methods according to the interests of the students. As the use of ICT tools is a modern student-centered method, Ashil's statement was as follows:

> *Most of the solutions are found in GeoGebra. We are using GeoGebra more and more. PHET virtual lab makes it easy to make the content practical in an interactive way. Pinterest also provides a lot of mathematical pictorial materials. ICT tools can be used to make projects, give projects, teach in a spiral learning structure, teach through mobile apps, and show them offline in the classroom when there is internet access from the website and offline.*

Regarding the different methods of using ICT tools, Sakula said:

> *I have used Mathematica software, Open Board, Mobile Learning, Mobile Apps, Websites, Calculators, Smart Boards, Smart TVs, Speakers etc. In general, using audio-video educational materials, ICT makes it simple and easy to teach in a shorter time. My opinion is that ICT should be used to enhance the teaching and learning process as a whole.*

While teaching mathematics in a modern way, the teaching method using ICT tools is very effective. If there is a sudden new arrangement during the teaching of mathematics, it is not easy for the teacher. Rudra's experience with various methods of teaching using ICT tools during COVID-19 was as follows:

> *COVID-19 has given us many opportunities to learn. During the lockdown, when the teaching and learning activities were carried forward through the internet, there was an opportunity to learn many things. In the beginning, PowerPoint slides were used more and more. Later, the teaching activities were carried out using GeoGebra and other software. During the lockdown, attempts were made to teach by connecting a web camera, keeping a board at home, and writing on the board. Remembering this, I felt that I had gained new work experiences in life. In the beginning, I had a bitter experience of teaching by taking photos from mobile phones and showing slides. While searching for many such options, I experienced what kinds of techniques should be used in alternative learning. In fact, we have not been able to learn many things. It is felt that there are still many things to be learned.*
>
> *There were also problems in online. However, facing the problem, we moved the class forward and managed to conduct the class even during the epidemic. Initially, we used to connect online through Zoom. It required re-connecting every* after- 40*minutes. Later, we started using Google Meet. However, more than 100participants could not be added to this. We separated each section and taught separately. As a result, an easy situation was created to test students' homework as well as to evaluate students for which Google Classroom was used.*

In my opinion, Students can use ICT to do math calculations, draw diagrams and solve problems. The most practical example of this is students calculating numbers using calculators. However, spreadsheets and computer algebra systems can be used for exam preparation, analysis and revision work, and for solving mathematical problems. Learners can easily perform statistical analysis on collected data using the graphing calculator's rich statistical features. Creating images with dynamic geometry packages like GeoGebra helps students understand, solve and prove geometry problems. Using ICT as a tool for students to find solutions, identify solutions to problems and understand what is happening helps them develop skills in using and applying mathematics. ICT can be a very powerful tool for mathematics subjects, but students need to acquire the necessary technical skills to make creative and efficient use of the opportunities offered.

From the above discussion, I found that ICT tools have been included in the mathematics teaching method to the maximum extent at present. The most dynamic software is GeoGebra, while the application PHET simulation, which uses interactive simulation method from the virtual method, is also being used. PHET simulation is an application that can be used both online and offline on laptops and mobiles.

In the same way, pinterest.com is a collection of pictures. It is used to teach various pictures, formulas, and mathematical concepts in mathematics. Various mobile apps, different websites, and math software are also being used. Word, Excel, and PowerPoint are used for various purpose, particularly under the office package.

Similarly, social media platforms such as Messenger, Facebook, WhatsApp, Tik Tok, etc. are used to convey mathematical content to colleagues, teachers, parents, and students. Electronic devices such as mobile phones, pen drives, hard disks, laptops, speakers, calculators, etc. are also used in teaching. Interactive tools

such as smartboards, smart TVs, projectors, interactive whiteboards, etc. are also used in teaching mathematics. In modern times, online education is conducted using the internet as well as internet facilities. Zoom conferencing, Google Meet, and other ICT tools are also being used for teaching mathematics in modern times.

Some Challenges for Using ICT Tools

What challenges did you face while using ICT tools during mathematics teaching? When asked, Ashil said:

> *Mainly, if you want to show the online source, you need high- speed internet, but sometimes it is not available and sometimes it is very slow. So, there is a problem with it. Despite that, we can download and run it offline wherever or whenever there is internet access. There are virtual labs that cannot be run offline but can be run online. Not being able to use it at the right time has also become a matter of challenge. Secondly, sometimes there are technical problems that take time to solve, and the set time is over. Electricity keeps coming and going.*
>
> *A skillful teacher should not only know how to use it, but should combine it with other tools and bring it to the center of the pedagogy. Time management, planning, coordination are all limitations of using ICT tool. Even a teacher who knows the content will not be able to use this ICT and it will not be used properly. Therefore, under pedagogy, the main thing is how to use ICT tools, select according to the content, mix-up, and then present as an output. For that, there are challenges to make time management, teacher training and manage all these activities to give combine output activities.*

Bigal's experience regarding the use of ICT wa as follows:

The first thing is that the mindset and willpower of the management are the most important things when we relate them to the context of public schools. If the materials we need for ICT are available in the management, then the teachers will also start working hard. Currently, the resources are less. So, the teachers are not willing to work. If the teachers feel that they need to find the content according to the time, they will get some more suports. Now, in terms of mathematics, it can be easily taken with ICT. But in the case of Nepal and in the case of this school, the first thing is the lack of resources. The economic situation itself seems fragile. Another thing is that when teachers have the mentality of saying 'Sakihalinchhani, Bhaihalchhani' but do not try to put it into practice, there are problems and challenges in ICT.

Some of the problems and challenges faced by Sakula while using ICT tools in the classroom were as follows:

Access to electricity has not reached everywhere. Internet connectivity has not reached in many places. When using gadgets, students watch unnecessary things, play games, and there is a possibility of abuse. Along with studying, they spend more time on social media than in the context. Students are likely to spoil handwriting while staying only in technology.

Rudra expressed the challenges of using ICT tools in mathematics teaching. He shared:

There are definitely many challenges. Our school is close to the highway. If there is such a problem, what kind of problems are there in schools in a rural area? What are the problems that I have experienced? When making a plan rather than teaching using ICT tools, there may be problems with the available technology; there is not enough internet facility. The problem of

load shedding is observed. Due to the need to complete the course in the prescribed time and to complete one class in 45 minutes, there is a problem in bringing ICT to the class. When such problems keep coming, it seems that the old method is correct, but it is not. What we can do to solve this is by managing time, providing smart boards, projectors, or smart TVs in every class, providing internet facilities in all classes and connecting them to teaching and learning activities. Since the teachers are also in a state of learning, it is not possible to use it in all subjects. Therefore, it is important to use technology in teaching and learning while enhancing the capacity of teachers. In this school, there are also very talented friends from other subjects. Many friends also find that there are not many jobs to choose from anymore. In any case, we need to move forward towards technology-friendly learning and create a learning environment using technology in mathematics. There is also a mathematics subject committee in the school, and even during the discussion, we are now working towards this task. There is a consensus that we will use ICT to advance the teaching activities.

From above discussion, I summarized that there were many challenges in the field of using ICT tools in mathematics learning and teaching.

Accessibility Issues and a poor Network Connection

Access to resources and ICT materials at school and at home is limited. Other factors such as poor resource configuration, poor quality hardware, inadequate software, or lack of personal access for teachers are current concerns. I also don't have internet access at school or at home. Very few people have lived in urban areas, and only a few have used the Internet. The internet is expensive for ordinary people to use.

Limited Technical Support

Technical support in schools enables teachers to use ICT in the classroom without wasting time. But most of the schools are unable to get technical support due to a lack of skilled manpower. It is a fact that even the existing teachers are not able to make simple things simple due to the lack of good training. Many ICT tools are kept in the school.

Some examples of lack of technical support are: ICT tools connectivity in the classroom; slow opening of the website; internet fluctuation; very slow internet connection; printer's problems and teacher's work on old functioning computers etc. Regarding the lack of technical support, Rudra said that, *Technical barriers impeded the smooth delivery of the lesson or the natural flow of the classroom activity.*

Lack of Effective Training

Training opportunities are not provided to teachers. Due to a very small number of training centers having given the opportunity for ICT training, the training materials have not been used in practice. It seems that the local government, state government, and the government of Nepal should provide sufficient training opportunities.

Limited Time

Time is very short, and it is not possible to teach ICT intensively in 40-45 minutes. It is challenging to fully utilize ICT due to the mathematics course content and the exam-oriented teaching method.

Lack of Teacher's competency

Very little consideration has been given to improving the capacity of teachers. It is impossible to use ICT tools without the teacher's support because the teacher brings the mathematics content to the classroom and to the students. Many teachers

lack willpower. Old teachers dislike using it. There are old principals in the administration. Their knowledge of ICT-related subjects is also limited. So, they are apathetic about using it.

ICT Tools Enhance Learning Capacity

Regarding how the use of ICT tools enhances students' learning abilities, Ashil says:

> *It is important to use ICT tools properly. The mathematics subject is a subject that helps in logical reasoning. It supports to see the difference from the different perspectives. It is necessary for conceptual understanding. Math supports to solve the problem. It also helps to make it short, fast, accurate and solve things practically. GeoGebra has been helping in problem solving, calculation, computation, etc. Learning mathematics is motivated by ICT tools. Writing the concept of formulas and solving them is actually not math; it is only a method. Therefore, teaching math is not a teaching method. After understanding math, it becomes easy and juicy. ICT tools have helped us to go on that path. Therefore, it seems that it is the responsibility of math teachers to continue using ICT tools and broaden its scope.*

ICT tools stimulate teaching and learning activities. They present new ideas. Also, the relationship with ICT tools further advances the students' abilities. Bigal said:

> *It is the most important part that increases the curiosity to learn the content of mathematics. When students' curiosity increases, they search for, look at, and learn the subject, which increases their critical thinking and can lead to new innovations. Therefore, ICT makes the children eager to learn the subject. It*

also motivates children to learn mathematics. Children who use ICT can progress in every field, which is the effect of ICT.

It can be found that the use of ICT is indispensable in mathematics teaching and learning because the children who use ICT search for a subject and use it. Therefore, ICT is very necessary in the current environment. It is necessary to connect every subject according to time, and it is also necessary to move forward in search of an easy means to make it accessible to students.

Sakula expressed her experiences as:

The use of ICT tools motivates students in mathematics learning and also increases students' critical thinking. It develops their logical thinking about the math content.In addition to this, they also come up with innovative ideas that they can search for and discover on their own. For motivation, ICT enhances the learner's abilities such as: what we see in 2D and what we see in 3D. Of course, what we see in 3D is useful for us. In addition to conceptual and durable learning, the habit of trying to learn by oneself has been developed. ICT also helps in the development of research habits.

When ICT is used, students' searching habits and thinking are also open.

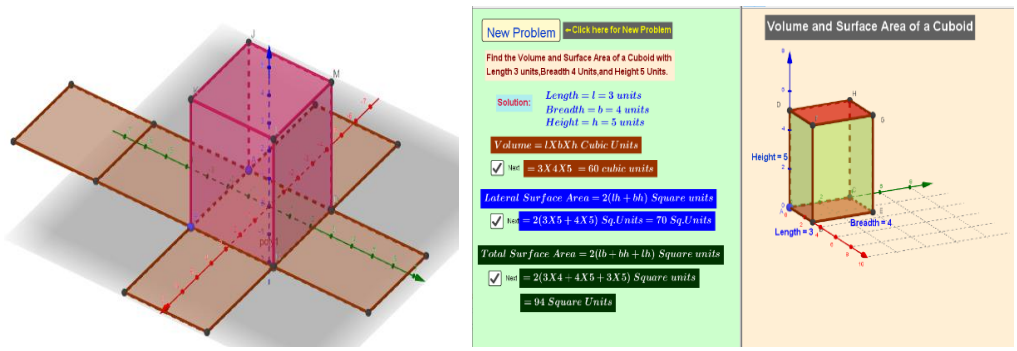

Figure 9: GeoGebra Model of Cuboid

If an idea is to be given, the students search for it in many ways. In the conversation, I asked one question for Rudra: What are the things that can be enhanced by the use of ICT in math learning? Rudra shared as follows:

ICT tools have developed critical thinking for students. For example, when teaching mensuration, if the area of the four walls is to be extracted, using cuboid and presenting the net of the cuboid from GeoGebra, extracting the area of the rectangles in the net and connecting them all together, the cuboid can be taught as a room. Finding the area of the four walls as well as coloring the area and finding the formula to find the area of the four walls can be facilitated at the same time. It enhances thinking skills. They can learn in a deep way. As a result, their critical thinking increases. Can the same problem be solved in different ways? Is this the only way to solve it? It also develops such thinking. Therefore, they try to think, see, and solve this problem from many angles. As a result, their logical reasoning power also increases.

Students learn to construct such formulas themselves rather than using formulas made by others. For example, how was the formula for finding the area of a circle constructed? While teaching that, the things they learn when extracting the area is what is the value of π *from* πr^2 *. There is also information about how it came about. It not only informs us about the use of the formula but also about how the formula has been developed. It also helps in the conceptual learning of students. In this way, it can be seen that it supports conceptual learning. Students not only learn but also develop the ability to teach what he has learned to other friends. However, in the course of learning, when the*

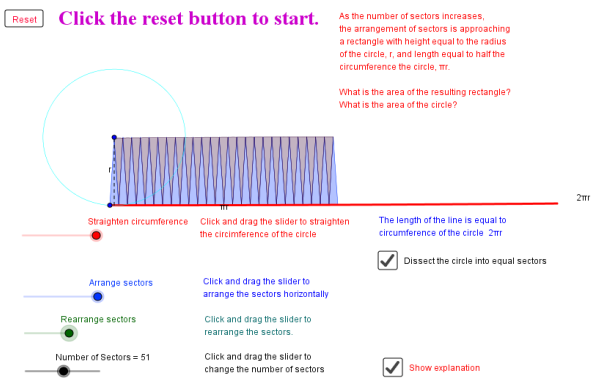

Figure 10: GeoGebra model of Formula of Circle

teacher presents the content, he should be fully prepared. Otherwise, the students may understand it wrongly. So, first of all, it is important to improve the ability of the teacher.

Using ICT in teaching, we can see that the students are very eager to learn and are excited to learn the things they don't know. What this shows is that when students express their desire from ICT, they are ready to learn about it. It becomes clear that the teacher should also be prepared to teach the things that the students want to learn.

Students are advancing a lot in the field of technology. Their abilities are amazing. We should be able to teach by understanding that ability. There is also a situation where the teacher teaches one thing and they find many things. There are many forward-looking students in the class who are also helping the teachers. If we can create opportunities for other students in the class to learn by using students who are skilled in technology, surely it will help to easily reach the students in mathematics learning.

From the above discussion, I sensed that if ICT tools are used, the following things can be done to enhance the abilities of students. These are discussed in detail here.

Critical Thinking Skills

Critical thinking involves actively and skillfully conceptualizing, applying, analyzing, and synthesizing information obtained or generated through observation, experience, reflection, reasoning, or communication and using it as a guide to beliefs and actions. It is the ability to use it as a guide in an intellectually trained process (Holyoak & Morrison, 2005). Critical thinking includes soft skills such as problem solving, finding causal relationships, interpreting data, evaluating arguments, and

maintaining flexibility and fluidity of opinions and views. ICT can improve these skills. Critical thinking can help us to better understand mathematical concepts in turn. It helps us solve any kind of problem and focus more on our strengths in understanding math.

Schools are introducing larger ICT tools into the instruction for students' progress. They hope to better prepare students for the growing world of ICT. In the classroom, using ICT tools can make math activities and learning more interactive. ICT can appeal to multiple senses and can improve students' mathematics learning skills through ICT materials.

Appropriate ICT tools in the classroom increase academic performance, confidence, class motivation, and student attendance. ICT tools help facilitate the learning of math problem-solving skills rather than just sitting and listening to students. It helps students develop critical thinking skills, apply mathematical knowledge to real-life situations, and develop problem-solving skills.

Simulation provides a place to learn from mistakes in high-risk environments and facilitates experiential learning. They embody many theoretical concepts, ensuring better reasoning and deeper understanding. Recent social media platforms allow people to communicate in two directions, share personal ideas and interests, form friendships, and socialize professionally. Managing the group's common interests and being open and able to process other people's opinions and ideas is important for critical thinking. It's an awesome device for progressing your basic aptitudes, but you ought to be mindful that some ICTs have a few pitfalls.

Professional Development

ICT tools have also supported the professional development of mathematics instructors. According to the participants, most of the GeoGebra and other ICT-

related tools were learned through online training. Similarly, the participants used social media and learned many things through YouTube videos. ICT tools helped in the professional development of mathematics teachers in the following ways:

GeoGebra Website

GeoGebra is dynamic math software for all levels of education, combining geometry, algebra, spreadsheets, graphs, statistics, and calculus into one engine. Additionally, GeoGebra offers an online platform with over 1 million free educational materials created by our multilingual community. These resources can be easily shared through the GeoGebra Classroom collaboration platform, which allows real-time monitoring of student progress.

GeoGebra is a community of millions of users in almost every country. It has grown to become a leading provider of dynamic math software that supports science, technology, engineering, and mathematics (STEM) education and new ideas for learning and teaching around the world. GeoGebra's apps, classroom resources, GeoGebra Classroom, and other features are available free of charge to the public.

Web Conferencing

It allows to join with other people in different locations through Zoom and Google Meet. It allows people to communicate with each other across national, international, and global boundaries and discuss across time zones. Additionally, it includes smart video and audio recording, selections such as polling and voting, chat, and a 'raise hand' highlight to show if you have questions or comments. Also, it includes report sharing, whiteboard, and web browsing capabilities. Members view data on their computer screens and listen to speakers and other members over the web.

Online Learning Platform

The Internet is host to numerous learning platforms. Some universities are offering full online courses. We can choose from both free and paid courses. Online learning platforms may offer reading materials as well as the ability to publish learning content. Some examples of online learning opportunities are provided by Khan Academy, PHET simulation, Learning Portal, Sikne Thalo, MIDAS E-class, and Education Sanchar. Web 2.0 technologies such as blogs, wikis, social bookmarks, and online groups have been used on online platforms.

Social Networking and Online Groups

Social media networks offer mathematics teachers the opportunity to connect with people working in fields relevant to their educational practice. The main use of such systems is numerical trading. Spaces like Twitter, LinkedIn, Facebook, Tik Tok, GeoGebra, and Google+ offer a snapshot of learning from creators, teachers, helpful trailblazers, and able-bodied people who don't share their data. The social media-based stage provides access to talented organizations and profitable assets for adult learners. These social media spaces create online communities that provide opportunities to share math content, ask questions that encourage collective learning, and potentially make connections that lead to job openings, advice requests, and increased opportunities for collaboration.

Social groups such as Messenger groups, Whats App groups, mail groups, Google groups, Facebook page groups, and so on also assist us by sharing the document with each group member. Posts can be voice messages, text and images, videos, and even audio files. Documents are often taken and shared within the group. This malleable online group feature is both a strength and a weakness. Posts can be in

a variety of formats, allowing broad participation in group interactions. Posts are random within the group as there is no control when posting.

Online Videos/Teaching Channel

There are numerous platforms like YouTube which give thousands of recordings. They can be implanted within the arithmetic lesson. They are broadly known as "instructive channels. These not only enhance the substance for instructors, but also give a rich learning involvement by appearing as professionally delivered directions. TED Ed, Stellarium, Video Teaching Channel, Teacher Tube, Pro Teachers Video, Edutopia videos, and teaching channel, etc. are the examples of teaching channels.

Formula Derivation Through ICT Tools

The development of formulas can be explained by using ICT tools in mathematics. By showing how to generate formulas by using GeoGebra, videos, and

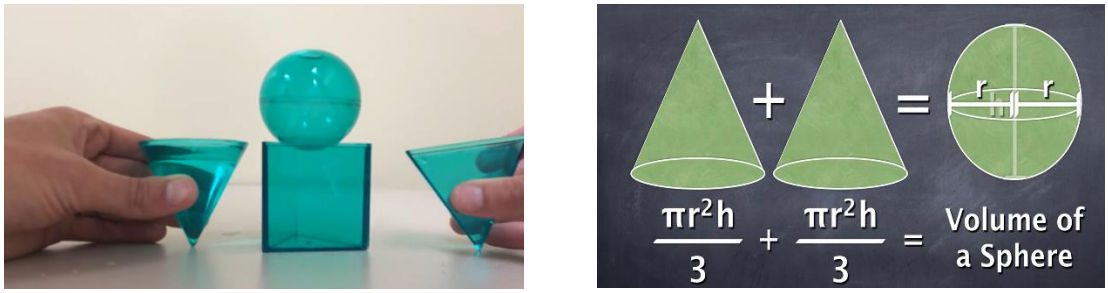

Figure 11: Model of Volume of a Sphere

animations, students can be removed from the habit of memorizing formulas. Students can develop more concepts by themselves if an example is given that uses the formula well. Here, the class teaching material is presented through video and animation of formula derivation using ICT:

If the formula for the volume of sphere is to be developed, then how it is proved with the conceptual development can be shown by the short video from ICT tools. Here the concept of a cone is already presented. The volume of two cones is

equal to the volume of the sphere. To confirm this, two cones with equal height and radius can be seen by pouring water on a sphere with the same radius and height. In this way, the volume of both is equal.

Therefore, if mathematics content can be presented using both technology and concrete materials, there is no doubt that mathematics will be conceptually learned.

Problem Solving Skills

Problem solving starts with identifying the issues, coming up with solutions, implementing those solutions and evaluating their effectiveness. In our country, the curriculum itself has prepared problem-solving content, and since the same kind of evaluation is done in the examination, there is a compulsion to advance the teaching and learning activities according to the content. But the current new curriculum has started experimental work with projects.

ICT tools develop the problem-solving skills of learning in the following ways:

Dynamic Representation and Exploration

GeoGebra is a dynamic software that does dynamic representation of images. Also, it helps to explore the picture in a scientific way, which helps in a clear understanding of the problem. In addition, it helps to develop thousands of problems from one problem and solve them all in one day.

Communication and Mathematical Discussion

Social media like Facebook, Messenger, Tutor, Tik Tok, LinkedIn, Google+, etc., help in mathematics discussion and knowledge sharing. Also, communication tools like Zoom, and Google Meet act as a bridge between two people for problem-solving.

Revise and Extend Content Explanation and Problem Formulation

Video channels like YouTube, Khan Academy, 3Blue1Brown, TED Ed, revise and extend the content and provide more explanation to clarify the problem. They also help with problem formulation and solutions.

To keep on Learning and Communication Activities

To keep on learning activities and communication activities about math on the mobile phone, laptop, and tablet. It helps to resolve the problem with students and other friends and also to solve it.

Mathematical Operation, Graphic Representation and Concept Information

Different software, mobile apps, online and offline calculator and online solution websites are used for this. Problem-solving becomes easy through this.

Classroom Management and Control

Apart from solving math problems through Google Classroom and different LMS systems, it is also easy to share the solution with the group at once. Therefore, these tools also help with math learning.

Concept Explanation

If there was a problem of not understanding any mathematics- related words, it can be cleared through Wikipedia, a mathematics dictionary, and other different websites. If we want to clear up a concept, we can go to the Pinterest website in picture and animation format and learn math through clear math ideas and funny ways from that website.

Innovative Ideas for Mathematics Learning

Mathematical content can be taught with new ideas, for which ICT tools are the best option. Presenting in a modern way in different ways is called innovative ideas. Teaching using online resources, dynamic software, practical real work, graphic

calculator, online calculators and different software is fun. Because of this, mathematical concepts are developed in an easy way. In small classes, the concept of math can also be shown through art. Mathematical concepts can also be presented by creating different artistic figures on paper or in digital format. Such art can be easily obtained from Pinterest. These works are also in animation format.

It is possible to create an environment for learning mathematics through different games. Mathematical games are also the innovative ideas for learning. Today's students prefer to play games and consider them fun. Therefore, if we can advance the mathematical content according to the student's mood, the student's mathematical perception develops while playing.

Another innovative idea is simulation. Maths can be learned and taught just like real material by running animations and values from a PHET simulation. If ICT tools are used in mathematics learning, innovative ideas are generated.

Motivation to learn Mathematics

ICT is increasingly being used in mathematics education to enhance teaching and learning. In addition to these efforts, we also need to improve students' motivation for mathematics. When teaching using ICT tools, students find it interesting and fun. Students are motivated and they continue to learn mathematics.

Dynamic software like GeoGebra provides student-centered collaborative learning and helps the students gain a better understanding. ICT tools develop the virtual learning environment. Different videos make it easier for students to learn by generating ideas in a fun environment. Similarly, the website material widens the scope of knowledge per subject and motivates learners to learn the mathematics subject matter.

Specially designed educational games can stimulate students' curiosity, help them develop clear learning goals during the game, and increase their motivation by encouraging them to be persistent in the process (Bai et al., 2012). In both roles, it is assumed that ICT tools can be used to promote motivation for mathematics.

Therefore, it seems clear from the above discussion that after using ICT tools, student's abilities will be enhanced as well as the way of learning will change. So, in general, ICT tools enhance critical thinking, professional development, formula derivation through ICT tools, innovative ideas, motivation to learn mathematics, and develop conceptual understanding.

CHAPTER V

FINDINGS, REFLECTIONSAND CONCLUSIONS

This chapter highlights the findings, reflections, and conclusions of the research from the data and related literature. The findings from the narratives have been explained as the main theme: teaching technique, critical thinking, students' motivation, some challenges, professional development, and enhancing mathematics learning capacity. I have brought the reflections of my research process and the conclusions of my research based on my findings. I have reflected on the process of my research and presented what I have learned after concluding my research study. This chapter also draws some conclusions, and implication as well as some future directions based on those findings.

Findings of the Study

In this section, I have answered my research question based on theoretical perspectives. How do teachers narrate their experiences of using ICT tools in teaching school mathematics? During this, I collected the personal experiences, ideas, and stories of the four research participants from different schools. I transcribed the stories of my research participants into the narratives. Then, I developed the themes from the narratives of the participants.

The teaching profession itself is a dynamic profession. With shifts in time, the teacher should also be able to make this profession dynamic. A successful teacher has the ability to advance their profession in accordance with time and environment. There are many experiences during teaching. Recently, the development and use of ICT has been rapid, and as the use of ICT tools in education is also increasing, it is natural for mathematics teachers to use ICT tools as well. Many things were obtained

from the research interview about what kinds of experiences there were during the teaching and learning of mathematics. It was also discussed by narrating it. Now the important things obtained from this discussion are presented in the form of findings under the following theme.

Use of ICT Develop the Modern Mathematics Teaching Technique

From the research data, ICT tools have been included in the mathematics teaching method to the maximum extent at present. GeoGebra is being used as the most dynamic software. GeoGebra helps the student understand, solve, and then prove a mathematical problem. The application of PHET simulation, which uses an interactive simulation method from the virtual method, is also being used. PHET simulation is an application that can be used both online and offline on laptops and mobile phones.

In the same way, pinterest.com is a collection of pictures. It is used to teach various pictures, formulas, and mathematical concepts in mathematics. Similarly, various mobile apps, different websites and math software are also being used. Word, Excel, and PowerPoint are used for various purposes most of the time under the office package.

Nowadays, social media platforms such as Messenger, Facebook, WhatsApp, Tik Tok, etc. are used to convey mathematical content to colleagues, teachers, parents, and students. Electronic devices such as mobile phones, pen drives, hard disks, laptops, speakers, calculators, etc. are also used in teaching.

Interactive tools such as smart boards, smart TVs, projectors, interactive whiteboards etc. are also used in teaching mathematics. In modern times, online education is conducted using the internet as well as internet facilities. Zoom

conferencing, Google Meet, and other ICT tools are also being used for teaching mathematics in modern times.

Use of ICT to Develop Problem Solving Skills

It was found that ICT tools developed the problem-solving skills of mathematics learning in the following ways:

GeoGebra is a dynamic software that does dynamic representation of images. Also, it helps to explore the picture in a scientific way, which helps in a clear understanding of the problem. In addition, it helps to develop thousands of problems from one problem and solve them all at once.

Social media like Facebook, Messenger, Tutor, Tik Tok, LinkedIn, Google+, etc., help in mathematics discussion and knowledge sharing. Also, communication tools like Zoom and Google Meet act as a bridge between two people for problem-solving. Video channels like YouTube channel, Khan Academy, 3Blue1Brown, TED Ed revise and extend the content and provide more explanation to clarify the problem. They also help with problem formulation and solutions.

It enables to keep on learning activities and communicating activities about math on the mobile phone, laptop, and tablet. It helps to resolve the problem with students and other friends and also to solve it. Apart from solving math problems through Google Classroom and different LMS systems, it is also easy to share the solution with the whole group at once. Therefore, these tools also help for math learning.

If there is a problem of not understanding any mathematics related words, it can be cleared through Wikipedia, the mathematics dictionary, and other different websites. For that, if we want to clear a concept, we can go to the Pinterest website in

pictures and animation format and learn math through clear math ideas and funny ways from that website.

Mathematics Teachers Facing Challenges for Using ICT Tools

From the research data, I found some of the challenges mathematics teachers are facing in the field of using ICT tools in teaching and learning mathematics. First is the limited accessibility and poor network connection. Second, the school has limited technical support. Third, there is a lack of effective training opportunities from local governments, state governments, and the Nepal government. Fourth, there is limited time for classroom teaching but large mathematics course content and the exam-oriented teaching method. Sixth, there is lack of teacher competency.

ICT Tools Help Teachers in Their Professional Development

ICT tools have also supported the professional development of mathematics teachers. I found that ICT tools helped in the professional development of mathematics teachers in the following ways:

GeoGebra website: GeoGebra is dynamic math software for all levels of education, combining geometry, algebra, spreadsheets, graphs, statistics, and calculus into one engine. GeoGebra resources and GeoGebra Classroom can be easily shared through the collaborative platform. GeoGebra's apps, classroom resources, GeoGebra Classroom, and other features are available free of charge to the public.

Web conferencing: It allows you to join with other people in different locations at the proper time over the Internet such as Zoom and Google Meet. It enables people to communicate across state, national, and global boundaries, as well as time zones. It enables introduction of checkpoints by audio and/or video. Additionally, it includes smart video and audio recording, selections such as polling and voting, chat, and a 'raise hand' highlight to show if you have questions or comments. It may also include

report sharing, whiteboard, and web browsing capabilities. Members view data on their computer screens and listen to speakers and other members over the web.

Online learning platform: The Internet is host to numerous learning platforms. Some universities offer full online courses. We can choose from both free and paid courses. Online learning platforms may offer reading material as well as the ability to publish learning content. Online learning opportunities are provided by Khan Academy, PHET simulation, Learning Portal, Sikne Thalo, MIDAS E-class, Education Sanchar and Web 2.0 technologies such as blogs, wikis, social bookmarks, and online groups.

Social networking and online groups: Social media networks offer mathematics teachers the opportunity to connect with people working in fields relevant to their educational practice. The main use of such systems is numerical trading. Spaces like Twitter, LinkedIn, Facebook, Tik Tok, GeoGebra, and Google+ offer a snapshot of learning from creators, teachers, helpful trailblazers, and able-bodied people who don't share their data or assets. Get involved as often as possible. The social media-based stage provides access to talented organizations and profitable assets for adult learners. These social media spaces create online communities that provide opportunities to share math content, ask questions that encourage collective learning, and potentially make connections that lead to job openings, advice requests, and increased opportunities for collaboration. Social groups such as the Messenger group, Whats App group, mail group, Google group, Facebook page group, and so on also aid in the professional development of teachers.

Online videos/Teaching channel: There are numerous sites like YouTube that offer thousands of videos to embed in your math lessons. TED Ed, Stellarium, Vimeo Teaching Channel, Teacher Tube, Pro Teachers Video, Edutopia videos, Teaching channel, etc. are the examples of teaching channels.

ICT Tools Enhance Mathematics Learning Capacity

According to the research data, ICT tools have worked in the following areas to enhance mathematics learning capacity.

Critical Thinking Skills

Critical thinking includes soft skills such as problem solving, finding causal relationships, interpreting data, evaluating arguments, and keeping opinions and views that are flexible and fluid. ICT and CBT can both reinforce these skills. Critical thinking can help us better understand mathematical concepts and, in turn, help us solve any kind of problem and focus more on our strengths in understanding math.

In an ICT-based educational environment, mathematical activities and learning become more interactive with the use of ICT tools. ICT can appeal to multiple senses and can improve students' mathematics learning skills through ICT materials. Appropriate ICT tools in the classroom increase academic performance, confidence, class motivation, and student attendance.

ICT tools help facilitate the learning of math problem-solving skills rather than just sitting and listening to students. It helps students develop critical thinking skills, apply mathematical knowledge to real-world situations, and develop problem-solving skills. Critical thinking requires collaboration. ICT tools promote critical thinking skills in teachers and students.

Formula Derivation Through ICT Tools

The development of formulas can be explained by using ICT tools in mathematics. By showing how to generate formulas by using GeoGebra, videos, and animations, students can be removed from the habit of memorizing formulas. Students can develop more concepts by themselves if an example is given that uses the formula well.

Innovative Ideas for Mathematics Learning

Teaching using online resources, dynamic software, practical real work, graph calculators, online calculators, and different software is fun. In small classes, the concept of math can also be shown through art. Mathematical concepts can also be presented by creating different artistic figures on paper or in digital format. Such art can be easily obtained from Pinterest. These works are also in animation format. Mathematical games are also innovative ideas for learning. Another innovative idea is simulation. Math can be learned and taught just like real material by running animations and values from a PHET simulation. If ICT tools are used in mathematics learning, innovative ideas are generated.

Motivation to Learn Mathematics

Using ICT tools, students find it interesting and fun. So, students are motivated, and they continue to learn mathematics. Dynamic software like GeoGebra provides student-centered collaborative learning and helps the students gain a better understanding. ICT tools develop the virtual learning environment. Different videos make it easier for students to learn by generating ideas in a fun environment. Similarly, the website material widens the scope of knowledge per subject and motivates learners to learn the mathematics subject matter.

Therefore, it seems clear from the above finding that after using ICT tools, the ability of the students is enhanced as well as the way of learning may change. So, in general, ICT tools enhance critical thinking, professional development, innovative ideas, and motivation to learn mathematics, and develop conceptual understanding.

Reflections of the Study

Reflection is process of evaluating and thinking about one's experiences and actions in order to gain new insights and perspectives. In research, reflection is used

as a tool to help researchers think critically about their own experiences and actions during the research process. I presented all the events that occurred during my research study, from the beginning to the end. Also, I presented how I envisaged my research agenda, how I formed my research problems, a flashback of my theoretical perspective, reflection on my methodological map, how I responded to my research questions, conclusion, implication, and future direction of the research study.

Envisioning My Research Agenda

When I was growing up in school, I did not see any ICT tools other than a calculator, a tape recorder, and a radio. After passing SLC, it was customary to learn a computer, but I did not have the money to learn it. My wish was fulfilled by The Reukai Nepal. I had the opportunity to take 3 months of computer training for free. When I went to study for my graduation in Pokhara, I realized the importance of computers and technology. At the same time, I went to the cyber cafe and spent some money with the lure of online data entry and earning dollars. At the same time, I wanted to buy a computer, so I bought a desk-top computer and started using it at home. I came to Kathmandu to study for a master's degree. I was studied ICT in mathematics in the second year of my masters. From that time, I realized the need for a laptop and decided to buy a laptop and use it, which is still running. The laptop helped me to study for TU's master's degree and KU's MPhil.

Since joining Kathmandu University, I have been given many opportunities to work and learn in technology. I continued to train other teaches accordingly. I continued to use it during teaching and learning. At the same time, in the year 2075, the Technology-Friendly Teachers Society of Nepal was formed, whose founder president was Bhupati Basyal. I got the opportunity to join the campaign that technology should be used in education from the beginning. Our campaign continued,

but with the approval of the government agencies, the participant-teachers' school was not included in our agenda. When the COVID-19 epidemic and lockdown situation affected world, schools were closed for months, and teaching and learning stopped. We used this time to connect with online friends from the organization who were spread across Nepal. We started conducting training programs by connecting through Zoom. After that training, we conducted training at the state level, which produced manpower. Te friends of the organization also conducted programs at the district level. At this time, the government policy of teaching through alternative means was also implemented, and instructions were issued to all schools to conduct school activities through virtual means for alternative learning. By this time, our institutional manpower had reached the local level and started conducting the program. Till the time, government agency was neither able to conduct training nor manage the technology.

Due to the demands of time and government policies, educational training centers started conducting online teacher training. However, due to the fact that the government manpower itself was not skilled and the teachers did not have enough access to technology, effective training could not take place as expected.

Taking into consideration the demands of ordinary teachers affiliated with the Society of Technology-Friendly Teachers Nepal, the organization created subject committees in which I was in the role of the coordinator of the mathematics subject. To advance the process of connecting mathematics with technology, online learning programs were held every evening from 8 to 10–11 pm. This process lasted for about 5–6 months, and I had the opportunity to lead it. I prepared a comprehensive program and conducted basic 18-day and advanced 33-day GeoGebra related training. In which mathematics teachers from all over the country participated in the training. I felt that I

had contributed something to the education sector, and I felt proud when mathematics teachers conducted the live training. Since then, I have been participating in training programs by being institutionally connected with many training centers, local level, wards, and schools.

I also started a digital learning campaign, saying that digital literacy is necessary for teachers. I am still thinking of bringing this campaign to the entire country. When the effect of COVID-19 gradually decreased, schools also opened, but there was no physical condition to conduct classes. ICT tools were used a lot while as alternative means. Even when classes were conducted physically, ICT tools were felt essential.

Meanwhile, my MPhil research project was left undone. To complete the study, I presented an agenda related to ICT in mathematics education. I took the proposal twice, but because it was quantitative, the department did not show much interest. Later, I made it an agenda as qualitative research, prepared a proposal that included my experiences and the experiences of teachers using ICT tools during teaching, and proceeded with the research work according to that agenda. My research agenda was- 'how do teachers narrate their experiences of using ICT tools in teaching school mathematics?'

Formulation of My Research Problem

When the agenda was prepared, it was difficult to agree on how to present the research, what to make the research question, what to propose, what to justify, and how to determine the limits of the research. I thought that I had done well, but when it reached the supervisor, it had a different sense. From this, I realized that the title, research question, and purpose was to be interconnected and reconciled in research. I realized that the title, research question, and purpose should be interconnected and

reconciled in research. With frequent meetings and discussions with supervisor Indra Mani Shrestha, I was able to complete the work.

Revisiting My Theoretical Perspective

While working for a long time as a guide for positivistic and post-positivist paradigms under quantitative, the joy of choosing Interpretivism under qualitative paradigm in this study was different experience. It felt like the first experience of life while advancing the research through narrative inquiry. In the research carried out with the social constructivism theory, there was an opportunity to present the interaction and practical experiences of the participants.

Revisiting Literature Review

During the course of study, I had the opportunity to study many papers that were suitable for the title and subject matter. Since my second proposal was related to action research, I got an opportunity to study many books and papers sent by HOD of the department. Also, I studied 2 books that I had bought myself. As I did not come up with an idea myself, I contacted the supervisor, Indra Mani Shrestha, and received many related papers, books, and journals through email. I also studied more papers and journals by searching the internet and downloading them. At first, it seemed that there were no studies related to ICT, but there had been many studies in foreign contexts. However, since narrative inquiry was less carried, I took this into consideration and continued the research by looking for literature.

Revisiting My Methodological Journey

During the research study, the question which method to use to advance the study became a matter of thought. Since I could not proceed with the quantitative proposal, I had to move towards the qualitative one. Even though it was uncomfortable, I started moving forward under qualitative. It was difficult to find

participants when advancing the narrative inquiry under the interpretivism perspective. Even with purposive sampling, it was not so easy to find teachers who teach using ICT tools. Since the state has invested in technology in the model secondary school, while looking for a mathematics teacher from the model secondary school, I contacted two teachers in Tanahun and one teacher in Chitwan. In terms of gender, it was difficult to find a female teacher using ICT.

I began the field study. Staying in Chitwan for one day and going to school the next day to meet with participants in Tanahun the same day was not possible. So, on the third day I reached Shuklagandaki municipality in Tanahun. After meeting in person and talking over tea and fruit for lunch, it was easy to do other interviews through Zoom and phone because the intimacy had increased after the meeting. This was how data was collected. After obtaining permission to record audio and video only for the research purpose, not for any other purpose, the participants expressed their opinions openly.

Revisiting my Data Collection Journey

When it was time to collect the data, it was difficult to prepare the unstructured questionnaire. I was confused about the scope, and after discussing with supervisor Indra Mani Shrestha, I was able to decide. At that time, I was staying in a home stay at Gwarko Sanu's Home in Lalitpur. After going to Chitwan and Tanahun from Lalitpur, I collected data and came back to this home stay, prepared a translation journal, and recorded the other necessary interviews on Zoom and mobile phones. From time to time, the supervisor used to come to the house and guide me, and in the evening, he would call and ask how much progress had been made. For about 20 days, I started writing the report without doing any other work.

Responding to My Research Question

My research question was- how do teachers narrate their experiences of using ICT tools in teaching school mathematics? Guiding questions were created according to this research question. I interviewed the participants. According to the research question, various themes were generated.

Revisiting My Report Writing

After data collection, interviews in Nepali were transcribed and developed as a transcription journal. When there was a problem with the translation, the journal was prepared in both Nepali and English languages using online translation. The journal was developed as a narrative, and a research report was written. In the report, the teacher's experiences were taken as a narrative, and the gist obtained from the narrative were coded and developed as a theme. I found it very difficult to do this task and gradually started to find a theme daily and connected those with various literature by looking at articles and journals related to that theme.

Conclusions

ICT tools are very important in mathematics teaching. Even abstract things can be visualized by making them dynamic, which can make the concept clear. Under pedagogy, the main thing is how to use ICT tools; select according to the content, mix-up and then present as an output.

In mathematics teaching, most teachers are trying to use GeoGebra software. In addition to this, other tools are being searched for and used. It is necessary to work in a real context using ICT tools to modernize mathematics teaching and compete with the global market. ICT tools are not perfect for mathematics education; they only support learning for easy, simple, and conceptual development. The use of ICT tools develops modern teaching techniques in mathematics teaching and learning, supports

professional development, and enhances mathematics learning capacity such as: critical thinking skills of teachers and students, formula derivation and application, generating innovative ideas, enhancing motivation to learn mathematics. According to the demand of time, mathematics teachers are trying to connect with modern technology. But they have been experiencing various challenges. The study has concluded that the use of ICT tools is a suitable option to advance the teaching and learning of mathematics according to time. But, it seems that teachers should increase their abilities and bring them to the classroom in a practical way.

Implications

Mathematics has been identified as a difficult subject at the school level, which is a misconception. How to establish it as a simple, easy, and practical subject depends on the role of the mathematics teacher. I myself have experienced the difficulties faced by mathematics teachers. This study has made a deep study of how ICT tools are viewed and used from the experience of teachers. This study has focused especially on teachers who try to use ICT tools. It motivates mathematics teachers to study the role played by ICT tools in mathematics learning and teaching in the future.

Considering the usefulness of this study, the use of ICT in mathematics helps develop critical and scientific thinking for both students and teachers. It motivates learners to participate in math learning activities anytime, anywhere. It helps exchange and share ideas among math teachers for professional development. ICT is also being used to improve access and quality of mathematics teacher education. ICT tools increase critical thinking skills, formula derivation and application, and generate innovation ideas in mathematics learning.

ICT tools such as GeoGebra, mobile app, different websites, mathematics software, Internet, computer, smart board, smart TV, laptop, tablets, and many other hardware and software applications can be appropriated in the mathematics teaching-learning process. These tools can give benefits in the areas of content, curriculum, instruction, and assessment of the mathematics. For the professional development of mathematics education, GeoGebra website, web conferencing tools, online learning platform, web 2.0 technology, social network and online group, and teaching channels should be used appropriately.

GeoGebra can be a suitable option in mathematics teaching method. PHET simulation, Pinterest, graphic calculator has made it easy to understand the content of mathematics. If mathematics can be taught online and offline by using various ICT tools and social media networks, it seems that it will be easier to understand mathematics content.

Displaying all these themes and conveying the experience of the participants and the experience of the researcher to the general stakeholders can be taken as the implication of this study.

Future Directions

This study focused on how teachers narrate their experiences of using ICT tools in teaching school mathematics. In the future, I would like to request other researchers to study the impact of ICT tools on mathematics learning and the academic effects of using ICT tools on students in mathematics teaching. Also, since I am engaged in the campaign of digital education, I have a plan of pursuing PhD study so that I can make additional efforts in this area.

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APPENDICES

Appendix-A Sample Interview Questionnaire for Mathematics Teachers

Section A: Demographic Information (The researcher will mark him/herself during the conversation)

1. Gender: Male/Female
2. Age: 18 - 35 years ☐ 36 - 50 years ☐ 51 and above years ☐
3. Educational qualification: ☐ Bachelor Masters ☐ MPhil /PhD ☐
4. Teaching experience in mathematics:

   Less than 5 years ☐ 5-10 years ☐ 11-15 years ☐
5. How many years have you started using a laptop/computer?

   Less than 3 years ☐ 3-6 years ☐ 6 and above years ☐

Section B: Information about ICT tools

6. How much do you know about ICT?
7. What kind of ICT tools do you think?
8. What are the ICT tools you use?
9. What kinds of ICT tools do you use in teaching and learning?
10. Can ICT tools be used in mathematics teaching?
11. What kinds of ICT tools have you been using while teaching mathematics?
12. ICT tools include computers/laptops, projectors, smart boards, printers, calculators, mobile apps, math software, GeoGebra apps, websites, social media, search engines, presentation/word processing tools etc. Did you use it?

Section C: Learning Experience about ICT Tools

13. How have you received the feedback from students after using ICT tools?

14. What kind of support have you received from the school in terms of using ICT tools?
15. Do you think ICT helps in learning mathematics?
16. What challenges did you find when using ICT tools in teaching mathematics?
17. In your experience, is there a difference in the learning levels of students who use ICT and when they do not?
18. How does your method help students change their problem-solving teaching habits?
19. How do your co-teachers react to your class? Will they be influenced to follow in your footsteps?
20. How do you choose this method (use of ICT) to teach mathematics? Or what methods do you use?
21. What would you like to say to ordinary teachers about the use of ICT tools in the modern era?
22. In your experience, in what ways do you think ICT has benefited students? How can ICT tools enhance learning ability?

Appendix B: Draft Consent Letter

To Date:

The Headteacher

Shree …….. School

……

REQUEST FOR CONSENT TO CONDUCT RESEARCH IN SCHOOL AND PARTICIPANT MATHEMATICS TEACHER

My name is Shree Krishna Acharya, I am a research student of Kathmandu University, Nepal. The research I wish to conduct for my MPhil dissertation is entitled "TEACHERS' EXPERIENCES OF USING ICT FOR TEACHING MATHEMATICS: A NARRATIVE INQUIRY". This project will be conducted under the supervision of Prof. Dr. Bal Chandra Luitel (Dean of School of Education, KU) and Asst. Prof. Indra Mani Shrestha (Co-supervisor, Department of STEAM Education, School of Education, KU).

I have provided you with major document with a copy of the approval letter which I received from the KU Research Ethics Committee.

Upon completion of the study, I undertake to provide the University with a copy of the full research report. If you required any further information, please do not hesitate to contact me on 98…… or via email shreekrishnaacharya69@gmail.com .

Also, I request for the permission to involve research participants of mathematics teacher Mr./Ms. …… …… for sharing the individual and teaching and learning experience about ICT tools in teaching school mathematics.

Thank you for your time and consideration!

Sincerely Yours,

Shree Krishna Acharya
Degree Candidate
Kathmandu University School of Education