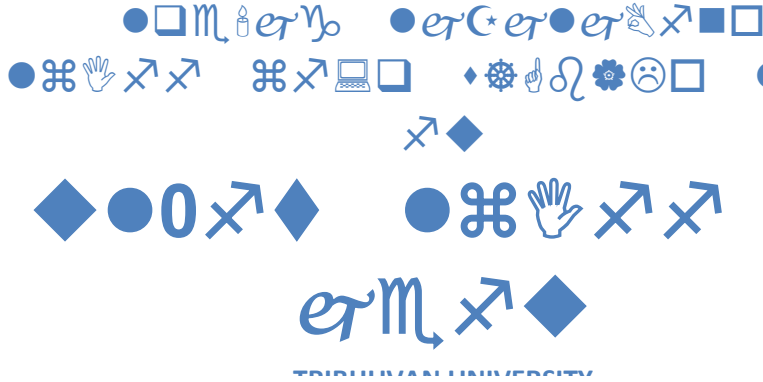


**DIGITAL TECHNOLOGY IN MATHEMATICS EDUCATION: A CASE  
STUDY**

**A  
THESIS  
BY  
UMESH AWASTHI**

**FOR THE PARTIAL FULFILMENT OF THE REQUIREMENTS FOR  
THE DEGREE OF MASTERS OF EDUCATION**

**SUBMITTED  
TO  
DEPARTMENT OF MATHEMATICS EDUCATION  
CENTRAL DEPARTMENT OF EDUCATION  
UNIVERSITY CAMPUS, KIRTIPUR  
TRIBHUVAN UNIVERSITY  
KATHMANDU  
NEPAL  
2021**



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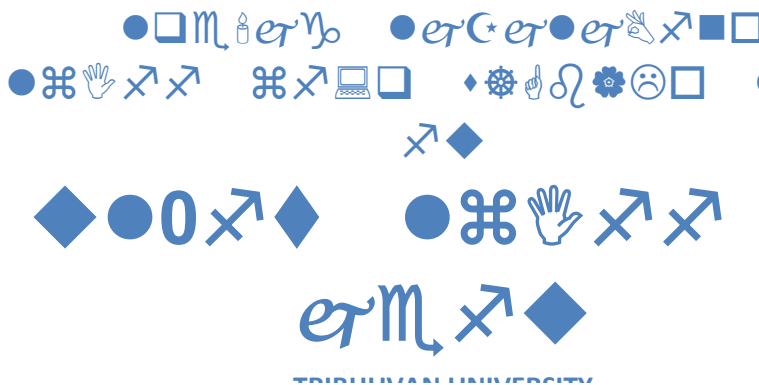
### LETTER OF CERTIFICATE

This is to certificate that Mr. **Umesh Awasthi**, a student of academic year 2074-2075 B.S. with thesis number **1588**, Exam Roll No. **7428324**, Campus Roll No. **11** and T.U. Regd. No. **9-2-327-203-2014** has completed his thesis under my supervision during the period prescribed by the rule and regulations of T.U. Nepal. The thesis entitled **Digital Technology in Mathematics Education** embodies the result of his investigation conducted during the period of **2021** at the department of Mathematics Education, University Campus, Tribhuvan University, Kirtipur, Kathmandu. I hereby, recommended and forward that his thesis be submitted for the evaluation to award the Degree of Master of Education.

.....

**Prof. Dr. Bed Raj Acharya**

(Head)



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**LETTER OF APPROVAL**

Thesis Submitted

By

**Umesh Awasthi**

Entitled

Digital Technology in Mathematics Education has been approved in partial fulfillment of the requirements for the Degree of Master of Education.

**Committee for the viva-voce**

**Signature**

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**RECOMMENDATION FOR ACCEPTANCE**

This is to certify that Mr. **Umesh Awasthi** has completed his M. Ed. thesis entitled **“Digital Technology in Mathematics Education: A Case Study”** under my supervision during the period prescribed the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to organize the final viva-voce.

.....

**Mr. Krishna Prashad Bhatt**

(Supervisor)

Date: .....

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## **DEDICATION**

This work is affectionately dedicated to my father late Ganga Ram Awasthi and mother Mrs. Nirmala Devi Awasthi who even in a very difficult situation gave me a great span of their life for what I am now.

**DECLARATION**

This dissertation contains no materials which has been accepted for the award of the degree in any institutions. To the best of knowledge and belief this dissertation contains no materials previously published by any authors except due acknowledgement has been made.

Date:

.....

Umesh Awasthi

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.....

Umesh Awasthi



## ABSTRACT

This is the study on “Digital Technology in Mathematics Education: A case study” The main objectives of this study were to explore the use of digital technology in mathematics education and to analyze the opportunities and challenges of using digital technology in teaching and learning mathematics education. In order to achieve this goal, two campuses Mahendra Ratna Campus and Sanothimi Multiple Campus in Kathmandu valley were visited for a week-long to conduct the study. Case study approach among qualitative research design was adopted for this study. The data were collected through interview schedule and classroom observation forms. To meet the purposes of the study two mathematics teacher and six mathematics students of bachelor and master degree were selected. The collected data were analyzed and interpreted by different theme based on conceptual framework and generated the different code according to the response of participants and triangulations method were used to conclude the research.

The study concludes that the use of digital technology in mathematics learning is increasing day by day and mostly mathematics students are practicing digital technology in mathematics learning. And also, digital technology provides great opportunity for schools/universities in developing and improving their teaching and learning processes. Technology provides additional opportunities for learners to see and interact with mathematical concepts. Students get more interested in learning and get intrinsically motivated to learn while technology is used. Abstract concepts of mathematics are visualized through the use of Geogebra. But the current status of use of technology is not satisfactory.

For the conceptual development of mathematics, one of the abstract subjects, the learning is being more effective by the use of digital technology. Digital technology in teaching and learning mathematics was rarely used before Covid-19 pandemic. The physical classes were neglecting the use of digital technology. After the rapid spread of Corona Virus, the schools were unable to run physical classes for long. Then, they started using digital technology in teaching learning mathematics massively. Those schools who were out of reach of technology got deprived from teaching their students. So, this situation made us all to realize that we cannot escape away from the use of technology. Similarly, we cannot ignore the increasing demand as well as necessity of digital technology in teaching and learning.

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**LIST OF ACRONYMS**

ICT: Information & Communication Technology

B.S.: BikramSambat

ICME: International Congress on Mathematical Education

NCTM: National Council of Teachers of Mathematics

USA: United States of America

S.E.E:Secondary Education Examination

FOE: Faculty of Education

SPSS: Statistical Packages for Social Scientists

SLC: School Leaving Certificate

T. U.: Tribhuvan University

## **Chapter I**

### **Introduction**

This chapter presents the background of the study, statement of the problem, the objective of the study, significant of the study, delimitation of the study and definition of related terminology.

#### **Background of the Study**

My journey of education started from Government school of Doti district. I give very less time for the self-study at home due to the environment of village. I remember few things as rote memorization and drill of multiplication table from 1 to 10 class. Teachers give us lots of time for the rote memorization. Teacher used to give the corporal punishment for not memorizing the formulas. Sometimes teacher used different chart and paper for illustration. But such kind of practices were not enough. Piaget's cognitive development theory (1936) emphasized on the manipulation of objects and craftwork to excel knowledge, teachers should explain the complex ideas with familiar examples and also can use story for middle child age. I remember the different stories were still in mind those the teachers told in the class. Stories remain larger time for the middle child age according to Piaget's. Digital Technology is universal in our society. The use of digital technology in the mathematics classroom has long been a topic for consideration by mathematics teachers. Digital technology tools in mathematics include: portable, graphic calculator and computerized graphics, specialized software, programmable toys or floor robots, spreadsheets and databases. Students will also have personal technology such as a tablet, a smart watch, a mobile phone or similar with which they are familiar to use mathematical focused applications. These tools are allowing pupils to collect data, and manipulate it using spreadsheets and databases for work in numeracy (Moseley, 2009).

Human life style is changed day by day due to the development of science and technology. Technology integration was helpful, meaningful, and necessary for human life. Traditionally the way of communication was through sharing their information, idea, skill and the use of paper-based approach but now the way of communication has been totally changed because of the development of digital technology and social media. Now a day, we use different type of digital technology such as computer, mobile, projector and social media such as email, internet, goggle,

you tube etc. which are particularly used on every stage of human life. The digital technology is used the purpose of saving time and for the good productivity by every person such as teacher, student, businessman, farmer officer etc. (Albalawi,2017, p.111-133).

Modern technology would be unthinkable we thought mathematics. The relation is reciprocal, since mathematics also needs technology. Today mathematician use computer not only for calculations, but also for numerous other tasks, including the search for proofs, validation and counter examples. Technology provides additional opportunities for learners to see and interact with mathematical concepts. Students can explore and make discoveries with games and digital tools. Digital technologies are electronic tools, systems, devices and resources that generate, store or process data. Well known examples include social media, online games, multimedia and mobile phones. Digital learning is any type of learning that uses technology. In recent years reference to 'digital technology in the classroom' (DTC) can be taken to mean digital processing systems that encourage active learning, knowledge construction, inquiry, and exploration on the part of the learners, and which allow for remote communication as well as data sharing to take place between teachers and/ or learners in different physical classroom locations. Only 21 percent of the total population of Nepal has access to the internet. Digital transformation strategies including an inclusive information society requires substantial investment in organizational capabilities, process innovation and institutional. Digital technology and social media for effective and interacting learning that must be used to self-learning, sharing based learning, collaborative learning, web-based learning and virtual learning for teaching and learning mathematics. Technology has the ability to enhance relationship between teacher and students. When teacher effectively integrate into digital technology in to subject area it makes teaching and learning more effective. Digital technology is very powerful tools for education. Also, it helps to contact with outside experts an audience beyond the teacher, meaningful contact between teachers and students working on the same activity out of school, ways for students to view and build on the work of others in their group or class, purposeful interaction between students in different schools, levels or classes across time frames and distance a means to enhance the participation

of all students. It gives facility for timely feedback from teachers and peers (Seechailo,2014).

In mathematics education we have seen a radical change in the range of uses of digital technologies to support teachers in the classroom, and to enable students to access school work from home (Adrian Oldknow,2011). So, we need to prepare for a new era in which students do not just have access to an electronic calculator, but the potential to run applications which can support all forms of mathematical and scientific computation, as well as to program their own. If we are to make best use of the potential of such digital technologies to radically improve teaching and learning mathematics, we need to take stock of what we know now, what we have seen to work, what we would like to see tried as well as how to introduce, support and sustain the innovations required. Technology has the ability to enhance relationship between teacher and student. So, teacher and students are connected to each other and can make good use of this platform for the working of their education. It helps to connect to their students in campus as well as with their old students (Sha,2017).

Digital technology helped the students and teachers to improve engagement, knowledge, encourage individual learning, encourage collaboration, and it also help teacher for content delivery. It gave resource, new opportunity for learning and way to collaborate to teacher and students. Also, it helps to connect with outside experts, meaningfulcontact between teachers and students working on the same activity out of school, ways for students to view and build on the work of others in their group or class, purposeful interaction between students in different schools, level or classes across time frames and distance means to enhance the participation of all students. It gives facility for timely feedback from teachers and peers (Seechailo,2014).

### **Statement of Problem**

The statement of the problem is the description of an issue currently existing which need to be addressed. It provides the context of the research study and generates the questions which the research aims to answer. So, the statement of the problem is the focal point of any research.

As I have mentioned above the mathematics education in Nepal school level and above is being difficult for the students because of the process of teaching learning inside the class. Knowledge is expanding day by day so teaching is becoming

one of the most challenging profession in our society. While learning mathematics, learner expect from facilitator to facilitate meaningful learning rather than just knowledge and skills (HmeloSilver, C.2004). In this modern period the use of Digital technology in teaching mathematics provides new possibilities in teaching profession. When I was studying the school level and higher-levelstudy, I was totally unknown about the digital technology and its use in mathematics education. When I sifted to Dhangadhi and joined Kailali Multiple Campus for my Bachelor's degree, it was the first time that I got a chance to use to smart phone which was very useful for solve many difficulties that I have to face during the learning period by its features of google search and the YouTube. During the Bachelors level study, I have understood the all features of google search and YouTube and the other digital materials and the advantages of digital technology.

After the completion of the Bachelor level, I sifted to Kathmandu and I have joined Tribhuvan University Central Department of Mathematics Education for the master's level. Here I got chance to learn and see the digital technology like as Projector, different software and also when I study forth semester, I studied ICT in Mathematics Education then I understood the importance of digital technology in mathematics education. The teaching and learning process using digital technology transformed drastically the mathematics learning which developed the curiosity inside me and this leads me on my research problem that is related to practice of digital technology in mathematics education. No previous study has done in investigating the practice of digital technology and its opportunitiesand challenging in teaching and learning mathematics education at Nepal. So, I chose the topic "Practice of Digital Technology in Mathematics Education" on my thesis to partial fulfillment of the master's degree course

### **Objective of Study**

1. To explore the practices of digital technology in mathematics education.
2. To analyze the opportunities and challenges of using Digital technology in teaching and learning mathematics education.

### **Research Question**

1. How digital technology is being practiced in classroom activities?
2. What is the status of using digital technology in mathematics education?



3. What are the opportunities and challenges of using digital technology in mathematics?

### **Justification of the Study**

Mathematics is one of the basic sciences of life. Mathematics used throughout the world as an essential tool in many fields, including natural science, engineering, medicine, and the social science. Technology provides additional opportunities for learner to see and interact with mathematical concepts. We can enhance learning process and make concepts come alive through engaging and interactive media. Digital learning has reshaped education in many ways. The covid-19 pandemic has forced many students out of school temporarily. Moreover, this poses a great challenge for prospective teachers to engage in digital learning during the covid-19 closure period. So, the covid-19 provides us to great opportunities to interact with digital technology. The justification of the study was a statement of why the study was being or conducted. The goal of the study might be to identify or to explain or predict a situation or solution to a situation that indicates the type of study to conducted (Khanal,2074).

One of the main challenges to mathematics teacher is to make a positive feeling in students toward learning mathematics. Therefore, teachers should be aware with the importance and effectiveness of digital technology in mathematics education. The results of this research will help to motivate students towards mathematics with the interaction of digital technology and it helps teachers to familiar with digital technology and make easy to provides the mathematical contents. In short, the justification of the study is pointed as follows;

- ) The study would provide the effectiveness of digital technology which would be helpful for policy makers and planners.
- ) It would help to extend students concerns with the use of digital technology in mathematics education.
- ) It would help to make familiar with opportunities and challenges of using digital technology in teaching and learning mathematics education.
- ) The study would provide the perception of teachers and students toward digital technology in mathematics education.

- ) The results and findings of the study would contribute for further researches on the use of digital technology in mathematics education.

### **Delimitation of the Study**

Delimitation is the boundaries of the study. There is the restriction intentionally placed by the researcher. Delimitation is the process by which a researcher determines the scope of his / her study by determining in which area, how many, what kind of tools he / she wants to study based on the available resources and time (Khanal, 2076). Due to the certain time and the other related factors the researcher cannot go to the entire field. The delimitations of my studies were follows:

- ) This study was limited in Kathmandu Valley.
- ) This study was limited only in those people who were related with the field of mathematics (such as math teachers, math students, mathematician).
- ) This study was based in qualitative research.
- ) This study was limited in Undergraduate and graduate level.

### **Limitation of the Study**

The main objective of this study was related to the practice of digital technology in mathematics education was to explore the practice of digital technology in mathematics education and to analysis the opportunities and challenges of digital technology in mathematics education. The study was conducted in two campuses of Kathmandu valley but the collected data did not come as expected from the students. Although the students gave short answers but the answer came as expected from the interview with the teacher.

### **Key Words**

**Digital technology.** Digital technologies are electronic tools, systems, devices and resources that generate, store or process data. Well known examples include social media, online games, projector, multimedia and mobile phones. Digital learning is any type of learning that uses technology. It can happen across all curriculum learning areas.

**Student.** These students who are studying and interested in mathematics.

**Mathematics education.** Mathematics education is the practice of teaching and learning mathematics, along with the scholarly research. Mathematics education is

referred to as the practice of teaching and learning of mathematics in a way of solving problems involving learning the algorithms and formulas necessary for computations. It is a platform to learn and teach mathematics with better way.

## **Chapter II**

### **Review of Related Literatures**

Literature is the source of new research. It gives the way and raw material for new research. Moreover, the review of the literature means critical analysis of related research articles. After depth and concise review of the literature, the researcher can identify the gap between the literature and adds the significance to the study. The review of related literature was a valuable step that guides the researcher to define the problem, recognize its significance and suggest promising data-collecting device, appropriate study design and source of data (Khanal,2074).

#### **Theoretical Literature**

The theoretical framework of the study was a structure that can help or support a theory of research work. It helps the researcher to define and see clearly the variable of the study (Khanal, 2074).

In the basic principles and standards of school mathematics The National Council of Teachers of Mathematics (NCTM) identified the “Technology Principle” as one of six principles of high-quality mathematics education (NCTM,2000). This principle states: “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students learning”, but it is fact that the mathematics teaching and learning in Nepalese schools is often focused on memorization of fact and formulae. Learners also showed lack of mathematics problem solving skills and higher order thinking skills, which cannot be easily developed in memorization of facts and formulae. The teaching and learning of mathematicsare that there should be a move from emphasizing memorization of facts by learners to a more learner centered approach where learners enhance on their questioning, elaboration, explanation and other verbalization mechanism, which contribute to the development of problem solving and higher order thinking skills in mathematics.

The research is connected with the connectivism as a Digital Age Learning Theory because the digital technology and social media generate the knowledge as connectives approach so that the digital technology and social media are also associated with this theory. According to this theory researcher tries to identify the main role of digital technology and social media for the teachers and students in

teaching and learning mathematics, which has generated the main approach of digital technology and social media in the field of education and learning process (Downes and Siemens, 2009).

The theory of connectivism explains that how technologies have created new opportunities for people to learn and share information across the World Wide Web and among themselves. These technologies include web browsers, email, wikis, online discussion forums, social networks, YouTube and any other tools which enable the users to learn and share information with other people. A key feature of connectivism is to see connections between information sources and to maintain that connection to facilitate continual learning. Stated simply, connectivism is social learning that is networked. Stephen Downes described it as: "The thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks" (Downes, 2007, para. 1). Connectivism is characterized as a reflection of our society that is changing rapidly. Society is more complex, connected socially, globally, and mediated by increasing advancements in technology. Rather than a new learning theory, connectivism offers an educator a model or mental representation that depicts something that cannot be observed or experienced directly (Dorin, Demmin, & Gabel, 1990). While the debate over the status of George Siemens and Stephen Downes' theory of connectivism will continue to be debated for many years, it is undoubtedly an important school of thought directly applicable to the use of technology in the classroom today. There is no doubt that online learning is a direct technological response to different learning cultures, methods, and inspirations. The combination of 3D interactive graphics and web technologies (Web3D) will permit instructors to create an interactive, realistic environment for the student in an online environment (Chittaro & Ranon, 2007).

The established learning theories of behaviorism, cognitivism, and constructivism each contribute in unique ways to the design of online materials through their ideas of how learning takes place: Behaviorist strategies teach facts and what is needed for understanding concepts, cognitive strategies focus on how the process should be implemented for the most successful learning, constructivist strategies use a shift toward real-life application, where the learner is given the opportunity to construct personal meanings from what is presented. Connectivism can

be used as an important instructional guide or theory to develop previous learning theories for their application to a globalized and networked world, but not as a standalone learning theory (Ally, 2007). Siemens stated that “Exponentially developing knowledge and complexification of society requires nonlinear models of learning and knowing. We cannot sustain ourselves as learning beings in the current climate with our current approaches” (Siemens, 2009 cited in Betsy Duke). With increasing technological connection through the internet, digital cities that collaborate on a wide array of topics have become a collective network that link communities both locally and globally. This paradigm shift and proliferation of social networks have caused educators to embrace this new option for knowledge for use in the classroom.

Basically, Technology influences all theoretical viewpoints by providing techniques and unique instructional methods. Every new idea or theory presented merits close examination for the possibility of helping students learn more successfully. With such a diverse population, an equally diverse selection of instructional techniques is necessary. Connectivism offers that diversity through a variety of networks, helping the new generations collaborate to find solutions to an ever-increasing number of questions. There is always a certain amount of core knowledge that is required to be able to understand any information presented. Depending on the field of study, this core knowledge will vary. If a person with limited core knowledge accesses Internet information beyond his or her ability to understand, then that knowledge is useless. In other words, a structured study using the existing learning theories is required in order to acquire the core knowledge for a specific field. While the theory presented by George Siemens and Stephen Downes is important and valid, it is a tool to be used in the learning process for instruction or curriculum rather than a standalone learning theory. It has also forced educators to look at what is being done in digital education and rethink, debate, and philosophize over how each part fits. Continually evaluating how each new generation learns with regard to instruction and curriculum serves to hold education to high standards.

**The connectivism theory in the field of mathematics has following aspects**

- ) Aspects of connectivism resonate with techniques and approaches known from professional practice to be broadly successful in alleviating mathematics anxiety and achieving effective learning outcomes.

- ) The pursuit of opportunities to approach the learning of mathematics as language and to form multiple links to connect new information with students' existing knowledge networks.
- ) Ability to see connections between fields, ideas and concepts was a core skill.
- ) Connectivism connect with the mathematics language to natural language and the converse.
- ) Capacity to know more critical than what was to know.
- ) Connectivism posits that mathematical knowledge is distributed across networks.

This view posits that the connectivity attained by forming links between mathematical know-how, language and other skills from the student's existing knowledge base serves to build understanding so that dependence on mathematical rules becomes redundant (in that, as a consequence of increasing fluency, they come to be seen as obvious consequences of the mathematics language rather than algorithmic procedures to be applied mechanistically). Every new mathematics learning activity should be approached from a language perspective, first identifying a common base of understanding with which students can connect so that concepts can be discussed in natural language before proceeding to translate them into the formalism of symbolic mathematics language. This methodology can, and should, be openly explained so that students understand explicitly that they are engaged in learning a language so that if their initial efforts are frustrated, they will recognize that many of their difficulties are, in reality, language difficulties and that these will abate as the mathematics language becomes less unfamiliar. Fortunately, students may be reassured, the vocabulary and grammar of mathematics is small compared to natural languages and very literal.

Connectivism presents itself as a pedagogical approach that affords learners. The ability to connect to each other via social networking or collaborative tools. Learning was viewed as multi-faceted and particular tasks define which approach to learning was most appropriate to their learner (Siemens,2003).

## **Empirical Review**

Empirical studies are reports of original research. Every study or research needs the knowledge of previous studies which can help the research to find out the new things and methodology for the study and clear the frontier of the study. Every researcher needs to observe the fundamental need to fundamental background of the related subject and past studies. The following section is an attempt to review the related studies and reports

Adhikari (2019) carried out the research on the topic “Practice of ICT in teaching and learning mathematics”. The objective was to find out that the teachers and students practices of ICT tools in teaching and learning mathematics and to compare community and intuitional mathematics teachers and students practices of ICT tools in teaching and learning mathematics. The sample was taken from 46 secondary schools mathematics teachers and 146 students (from 15 community and 8 institutional secondary schools) of Dhankuta district by stratified random sampling method. The survey design was conducted to achieve the objective of study. The practices of mathematics teachers and students was measured in five-point rating scale. The data was interpreted by using SPSS software version 21.0 to get the value of statistics chi-square test, percentage, mean, and standard deviation and t-test for objective first and second respectively.

By analyzing and interpretation of obtained data, the researcher found that secondary schools and mathematics teachers and students has minimum practices of ICT tools in teaching and learning mathematics. It is concluded that community and institutional secondary school’s mathematics teachers has no significance difference in practice of ICT tools in teaching and learning mathematics. Likewise, community and institutional secondary school’s students has significance difference practices of ICT tools in learning mathematics. This shows that community schools students in learning mathematics.

Similarly, Zovko (2016) present a dissertation entitled “The Use of ICT in Teaching Mathematics-A comparative analysis of the success of 7<sup>th</sup> grade primary school students”. The purpose of this study was to examine the impact of the application of ICT tools in teaching primary school mathematics. The student’s success in mathematics exam in the linear function unit was evaluated in two group. The first



group 90 students attended mathematics classes without ICT tools in teaching (school years 2008/2009 and 2009/2010). The second group 110 students (school years 2012/2013 and 2013/2014) attended mathematics classes with an extensive use of ICT in the teaching process. The first group of students successfully solved  $48\pm 26\%$  of the linear function test while the second group successfully solved  $58\pm 26\%$  of the same test. The results showed a significantly higher solving rate in the group of students who attended classes in mathematics where ICT was used in teaching ( $p=0.005$ ). ICT supported mathematics classes, in the example of linear function unit significantly improved students results in written exams. The results of the study reveal that ICT in teaching mathematics leads to better learning and knowledge acquisition in primary schools.

Also, Oldknow and Knights (2011), conduct a study entitle "ICT practice in school in United State" Technology in a variety of forms is becoming increasing common in classrooms in the United States, as it is in much of the rest of the world. In fall 2005, nearly 100 % of public schools in the United States had access to the internet, compared with 35% in 1994 and 94% of public-school instructional rooms had internet access, with little difference by school characteristics (Wells and Lewis, 2006). Interactive white boards are becoming more and more prevalent in schools; in 2007, 21% of the classrooms were equipped with them, 35% in 2009, and the prediction is that by 2011 nearly 50% of US classrooms will have interactive white boards (ICT Products Market Report, 2008). Another type of technology, classroom response systems or 'clickers', was used in 16% of the classrooms (Texas Instruments Education Technology, 2009). Online courses are becoming more common, particularly for students in small schools primarily as a way of reaching underserved students not as a preferable alternative to classroom instruction. Recently, however, policy-level calls are looking for online instruction as a cost-efficiency strategy. As of 2008, 25 states have or support statewide virtual schools, usually for middle or high school grade spans; four states offer elementary programs. An increasing number of states (currently 27) offer computerized state assessments to at least some students (Bausell, 2008). The state of Maine has programs in place to provide every student with a laptop or access to equivalent technology, but how this is reflected in classrooms, particularly mathematics classrooms, has not been documented. Despite the advances in technology as a communication and interaction medium, the hand-

held calculator is still the most universally adopted technology in mathematics classrooms. About 76% of the US 4<sup>th</sup> grade students have access to a four-function calculator, a number that has been relatively constant over the years, with about 6% having a graphing calculator (NCES, 2008). The use of graphing technology for students in grade 8 (about age 14) shows a slight positive trend. The frequency of calculator use at the secondary level varies according to the type of course, with students in algebra and higher courses more likely to use graphing and other calculators than students in pre-algebra or regular courses (Braswell et al., 2001). In 2005 (NCES, 2008), 62% of grade 12 students reported using a calculator for homework every day or almost every day with another 16% using the calculator two or three times a week, 64% of the students usually used a graphing calculator. About 43% of the students used a graphing calculator outside of school. Less than 25% of students in grade 8 and 20% of the students in grade 12 reported doing anything with computers; this includes the few who reported using computer software as a resource for extra support for learning (NCES, 2008).

Pahadi (2019) has conducted an unpublished thesis on “Perception of students toward digital technology and social media in learning mathematics” In this study the sample was 100 students of central department of mathematics. The study was related to quantitative research. The main objective of this study was to find out the perception of student toward digital technology. He concluded that there is no significant difference between the perception of boys and girl’s students. This study shows that there is positive perception on digital technology in mathematics.

Joshi& Ram (2016) present a dissertation entitled “Use of ICT in Mathematics Teaching in Secondary Schools of Nepal” Mathematics teachers of secondary schools of Nepal are using ICT for documentation purpose and less use of it in teaching learning. That also indicates that computers of schools have been used for official tasks and computer subject teaching because all schools have taken on the basis of availability of computer facility from developed areas of the country. Mathematics teacher’s opinions found to be highly agreed in terms measured items. So many studies have same results. Private school teachers were using ICT in school more than their public counterparts even male and female teachers were not significant. In terms of opinions of mathematics teachers, private and urban school teacher have significant result with public and rural school teachers respectively.

Results also indicate that private and urban school teacher have higher results. then public and rural counterparts in terms of ICT uses in school and their opinions towards its uses. Maximum research shows benefits of ICT uses in several aspect of formal education system. Result shows that it helps to increase student enrollment rate, student motivation, attendance rate, and decrease dropout rate, class repetition rate and class leave rate of the students which are directly or indirectly related to Education for All and Computer Literacy. ICT has several additional roles in the field of education even mathematics teachers not highly using ICT in several tasks hence all stakeholders should be investigating the cause and must find essential solutions. Public and rural schools have more poor condition so some additional programs should formulate and effectively lunch for them.

Rana (2019) present a dissertation entitled “The status of ICT in schooling in Nepal” There is a small body of writings related to the status and practice of ICT in education in Nepal. Several researchers (Dawadi & Shakya, 2016; Pangeni, 2016; Rennie & Mason, 2007; Shields, 2011) reported the expansion of internet infrastructures throughout Nepal and suggested that these should increase the possibility of e learning and enable school teachers to access the latest online information and so facilitate rural school student’s education. However, Thapa and Saebo (2011) reported that a lack of high quality internet, electricity, and supporting infrastructure are major challenges in Nepal's rural schools. Dawadi and Shakya (2016) reported the lack of skilled workforce, unreliable and costly internet facility, low level of ICT literacy in rural communities, high hills and mountains, lack of hydropower in the countryside and low power solar energy, and lack of security for ICT infrastructures. Rana (2018) reported a range of problems in the introduction of ICT in rural primary education in Nepal and suggested that the strategies currently used to overcome them are inadequate and potentially unsustainable. Internet World Stats (2017) reported that about 21.9% of the total population in Nepal were active Facebook users in early 2017, and it was calculated that the number of internet users crossed 58.72% of the total population in the mid 2017 (News24Nepal, 2017). However, there is little evidence of school teachers in rural areas in Nepal participating in online communities and share their problems and ideas. Although the Nepal Wireless Network Project, which uses ICT in various sectors such as health, education, and micro level business in rural communities in a mountainous district in

Nepal, has potentially improved many aspects of rural communities, digital technology is too costly for the majority of the population. Sharma (2017) notes that per capita income of Nepal is about US\$730, and so the poor economic status of many individuals is a barrier to afford expensive digital technology. Bhatta (2008) identified that teachers in rural primary schools needed to develop computer literacy. Smith (2009) found that, although schools of education are responsible for improving the quality of initial teacher training, teacher education program (faculties of Education at universities) in Nepal do not cover ICT education. Dixit (2009), however, reported that radio, one particular ICT tool, was integrated into teacher training in 1980 and has continued in training programs in Nepal. Bhatta (2008) argued that the generic teacher training module should be redesigned on the basis of ICT implementation to enable teachers to stay up to date with improving practices in their teaching. He noted the challenge lies in how teachers can integrate digital content into their teaching. However, the School Sector Development Plan, 2016–23 states that funding for equipping primary schools with ICT infrastructure is not available (MOE, 2016).

Also, Mulenga (2020) present a dissertation entitled “Is COVID-19 the Gateway for Digital Learning in Mathematics Education?” Digital learning has reshaped education in many ways. The purpose of this study is to respond to the question of whether COVID-19 is the gateway for digital-learning in mathematics education. To this end, this study explores some uptakes of social media platforms by prospective secondary school teachers. Data was collected from 102 prospective mathematics teachers from the Copperbelt University (CBU). Cluster analysis approach was used. Results revealed that participants’ scores for digital learning in mathematics in cluster 2 were higher than those in both cluster 1 and 3. This is a clear indication that prospective teachers in clusters with low scores are more likely to exhibit low skill levels in the use of mobile technology and the adoption of social media in relation to mathematics pedagogy during the COVID-19 crisis. Results show different patterns. However, overall results show that digital learning could be a positive response to COVID-19 closure period.

Also, Dhital (2018) conduct the study entitled “Opportunities and Challenges to Use ICT in Government School Education of Nepal” Information and Communication Technology (ICT) plays strenuous role to make teaching and learning activities more meaningful. It is one of the most efficient tools for advancing

knowledge and skills. It is necessary for quality education in government schools in Nepal. This study reviews the concepts and roles of information communication technology in government school education of Nepal. It highlights the challenges facing in use of ICT in government school education of Nepal. It identifies how ICT can be used to enhance quality education of government schools in Nepal. Problems such as lack of resources (viz. qualified teachers, hardware, software, electricity etc.) and poor project implementation strategies militate against these efforts. This study recommends that both government and non-government organizations should help to facilitate skilled manpower, stabilized electricity supply, hardware resources and software resources to enhance the use of ICT in government schools.

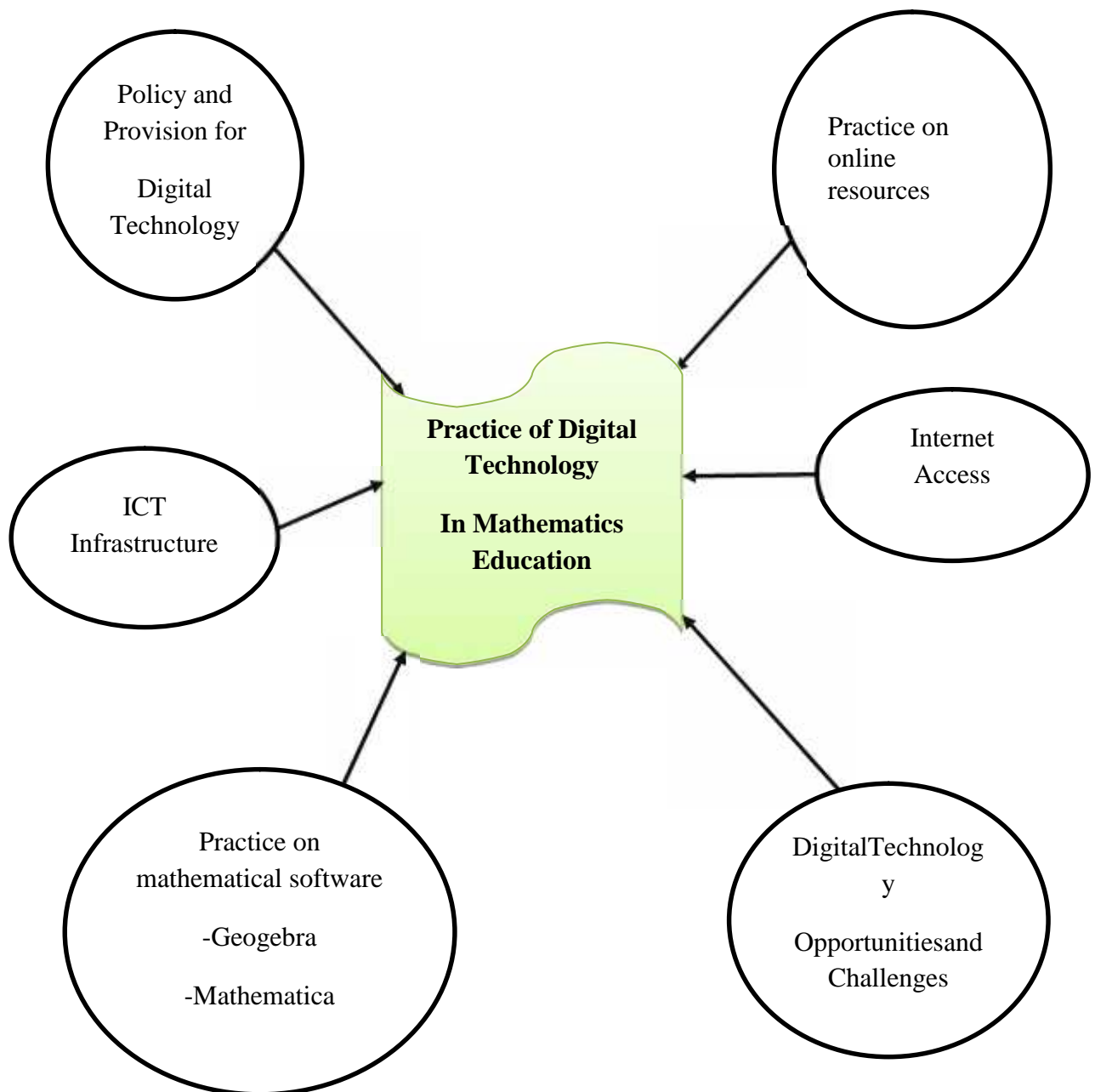
Likewise, Dahal & Dahal (2015) conduct the study titled “Opportunities and challenges to use ICT in Nepalese Mathematics Classroom” ICTs provide great opportunity for schools/universities in developing countries (Like our) to improve their teaching and learning processes. So far, most of the schools/universities in developing countries possess basic ICT infrastructure such as internet, computers, video, audio, and mobile technology facilities that form the basis for the establishment of e-learning. It argued that, schools/universities in developing countries should adopt e-learning technologies to improve teaching and learning processes. Therefore, before implementing the ICT familiar curriculum in school to university level, the Ministry of Education Nepal, Curriculum Development Centre and other related sectors need to think for removing the challenges that we are facing. We think at first the Ministry of Education need to make and implement the suitable policies, aware programs, training programs etc. related to ICT and also local educational sectors are also require to actively involve for develop and implement the ICT familiar curriculum in each educational level.

### **Research Gap**

- ) In addition, many other types of research were done only related to school-level mathematics. Thus, the research gap between other research and my research was the practice of digital technology in mathematics education in graduate and undergraduate level.
- ) Many researches are about practice of ICT, Use of Geogebra and Mathematica in mathematics education but my research was related to practice of digital technology in mathematics education which is another research gap between another research and my research.

### Conceptual Framework

A conceptual framework refers to the connection of the research variables in the study as in compact form. The conceptual framework is developed based on the researcher's understanding about the research variable and research process using some aspects of the theoretical framework. Conceptual framework was the plan or specific frame on which whole study is established in diagram. It provided the general picture of whole study from where the reader can conceptualize the whole idea of the research.



*Figure 1:* Conceptual Framework

**Practice on online resources.** Any resources available on the internet and google for teaching and learnings are online resources. The internet and google are the most popular online resources for mathematics learning.

**Internet Access.** Internet access is to ability of individuals and organizations to concern to the internet using computers, mobile device and to access service such as email and the World Wide Web. Various technologies at a wide range of speeds have been used by internet service to provide this service.

**Digital technology opportunities and challenges.** The development of digital technology in mathematics education is faced with many challenges. Digital technologies have been used as a way of acquiring new knowledge and skills in college. But we have many challenges include inadequate funding, lack of basic infrastructure, lack of qualified personnel and lack of policy formulation and implementation. The major challenge in our context is the required physical infrastructure for implementing digital technology. Nepal still experiences a lag in its implementation. This continues to widen the digital divide and the access to digital facilities as a major challenge facing in Nepal. If we fulfill the basic infrastructure for digital technology, it provides great opportunity for schools/universities in developing countries to improve their teaching and learning processes.

**Practice on mathematical software.** Mathematical software is the software used to analyze or calculate numeric, symbolic or geometric data. It is a type of application software which is used for solving mathematical problem or mathematical study. Geogebra and Mathematica are the most popular software for solving problem and study of mathematics.

**ICT Infrastructure.** Information and communication technology (ICT) infrastructure management is the process of managing equipment, Software and service. The goal of ICT infrastructure is to use proven, repeatable processes. This is important to providing a stable operating environment for everyone using the technology. The term infrastructure in an information technology context refer to collection of hardware, software, networks, data centers, facilities and related equipment use to develop of information technology.

**Policy and provision for digital technology.** Policies and practice are designed to influence determine all major decision actions, and all activities take place within the boundaries set by them. Practice or procedures are the specific method employed to express policies in action in day-to-day operations of the organization.



## **Chapter-III**

### **Methods & Procedures**

This chapter deals with the research methodology. The methodology of the study guided the whole study along with its scope and it help to researcher to easily collect and analysis of data. The following methods and procedures were adopted to conduct the research for improvement of the study and fulfill the objective of this study. This chapter consist the research design of the study, area of study, selection of respondent, data collection tools and techniques, data collection procedure, data analysis procedure and ethical consideration.

#### **Research Design**

The research design is intended to provide an appropriate framework for a study. A very significant decision in research design process is the choice to be made regarding research approach since it determines to show relevant information for a study was obtained, however the research process involves many interrelated decisions.

Research design is the plan and procedure for the research (Creswell,2008). This study was based on case study which is the types of qualitative research. Case study research is an investigation and analysis of a single or collective case, intended to capture the complexity of the object of study (Stake, 1995). A comprehensive of a social unit-be that unit person, a group, a social institution, a district or a community is called a case study (Khanal,2074). The purpose of case study research is to generate clear, systematic and precise descriptions of the meaning of experience. I wanted to gain concrete, contextual, in-depth knowledge about specific real world of this study. The major concerned of my study was to find out the practice of digital technology and opportunities and challenging of digital technology in teaching and learning mathematics education. So, for achieving this purpose I was used case study research design because in case study research design the data is collected through by direct observation in natural setting.

#### **Area of the Study**

The area of this study was based on undergraduate and graduate level students from two schools in Kathmandu valley. In the rural area there may be a shortage of qualified teachers, students may not have access in the digitality and also in the rural

area there are so many problems to use of digital technology. I knew the practices of digital technology and also the challenging and opportunities of digital technology. For this the facilities relating to the digital technology was available so I had choosed two schools in Kathmandu valley for my study.

### **Selection of Respondents/ Participants**

For the participants; I had selected the mathematics teachers and students of Mahendra Ratna Campus, Tahachal and Sanothimi Multiple Campus, Sanothimi, Bhaktapur using purposive sampling technique. I selected two teachers who taught mathematics education and six students who had been studying mathematics education from sampled schools which I had choosed for my research based on the conceptual framework. I had used purposive sampling technique for selection of Participants.

### **Data Collection Tools**

Interview and observation were the main tools used to collect the data to fulfil the objectives of this study.

**Interview.** An interview is essentially a structured conversation where one participant asks questions and the other provides answers. Interviews usually take place face to face. It is the process of data collection from face to face with interaction. Interview is a two-way interaction between interviewer and interviewee in which the interviewer creates situations that can attract the attention of respondents for an enough period of time in asking questions and answering the questions which is interviewee puts his/her understanding and meaning (Khanal, 2073). This is also one of the major data collection tools which provides basic and personal information towards research. The interview supports the qualitative data to make a valid research. I developed the different interview schedules for student's interviews and for mathematics teacher's interviews. I took in-depth interview with mathematics teachers and students using open ended questions and unstructured questions. In-depth interviews helped to make face to face communication with the students and also to get information about the personal gestures, habits, attitudes of the students. Also, it helped to understand the personal thoughts, ideas and experiences of the students.

**Observation form.** Observation note was used to identify the use and practices of digital technology in mathematics educations, interactions of students-

students and teachers-students about using technology in classroom and the effectiveness of use of digital technology in classroom teaching and learning. I observed mathematics teaching/learning classrooms of each sampled school for three times.

**Interview guideline.** Two forms of interview guideline were developed. One was given to students and the other one was given to teachers. There were structured guidelines composed of open-ended questions. The guidelines were based on Christensen and Knezek (Molina-Toro et al., 2019) instrument for assessing the impact of technology of education, but was contextualization Nepalese context Dhital, H. (2018).

### **Quality Standard**

After completing the construction of these research tools, it was necessary to maintain quality standard. Quality standard refers to how well a test measure and what it is purposed to measure. Quality standard of research tools was determined with the help of related theory and subject expert. To determine the quality standard of research tools the interview was taken over a period of time with the selected samples. Further the purposive sample technique was adopted to maintain the trust of the study. I also used tools to ensure the internal validity by observing the same data on the basis of conceptual framework develop in previous section.

### **Data Collection Procedure**

For the collection of data, I visited in each sample school which were selected for my research and then I organized the interview schedules with related person and visited the classrooms also. After the preparation of my interview question, I prepared the interview schedule with related students and teachers. Then the data was collected according to the interview schedule time. I observed the classes of mathematics three times taking the permission of depart head and mathematics teacher.

I collected the data separately through in-depth interviews with the concern of related mathematics teacher and students. I used primary sources and secondary sources for data collection procedure. The primary information was collected from mathematics teacher, mathematics students and the secondary information was collected from article, reports, books newspapers and other sources. After

collecting the data, I interpreted and analyzed the data then the finding and the conclusion was drawn.

### **Data Analysis Procedure**

After collection of the data from selected samples using interview guidelines and classroom observation notes I analyzed and interpreted the data. For the purpose of analysis, the themes were drawn out and analyzed for answering the research questions. Methodological triangulation was used by gathering data by means of different data collection methods such as in-depth interviews. Mainly three types of sources were triangulated such as digital technology use, teaching- learning styles of mathematics and classroom observation and taking interview with mathematics teacher and students. Thick description was done through head-teacher about respondent and study site. The important paraphrase with same meaning was brought together and summarized to support the argument whereas less relevant passages with same meaning are skipped for the ease analysis. Cross match, Triangulation, thick description and member check was adopted to maintain the validity and reliability of the research study. Triangulation aimed to enhance the process of qualitative research by using multiple approaches. Methodological triangulation was used by gathering data by means of different data collection methods such as in-depth interviews, focus group discussions and field notes Data triangulation was secured by using the various data sets that emerged throughout the analysis process findings.

This study was limited into qualitative research therefore the major part of data analysis was based on descriptive analysis. The data collected from interview and class observation was analyzed descriptively on the basis of conceptual framework. To analyze the collected data, I followed the procedure organize the data, editing the data, coding and decoding the data, building theme, reporting and finding procedure. Firstly, I constructed different theme based on conceptual framework then I organized and edited the data and then I generated the different code according to the response of participants and also recoding the data according as similarities. After coding and decoding the data, the researcher gave the title for them and reporting and finding the procedure. After analyzed the collected data, researcher used the triangulation method to conclude the research.

**Ethical Considerations**

Ethical Considerations can be specified as one of the most important parts of research. The ethical considerations of my research studies where the data was taken with the permission of campus chief and the guidance of my supervisor. Data was taken by consent without any harm, the privacy of the participants was secured and respected for privacy, I did not make hindrance in the learning process during class observation, all the information was managed with strict confidentiality, I neither fabricated the data nor did falsify in the reporting, I respected the autonomy of participants for answering the question. and also, the researcher had informed consent in recording the interview.

## **Chapter-IV**

### **Analysis and Interpretation**

This chapter deals with the analysis and interpretation of data. According to the set objective of the study, researcher marked the responses of the students very carefully and noted their outcomes systematically. Then on the basis of the observed and noted information the analysis and interpretation was carried out.

The information was collected through observation and interview with student and teacher. This entire phenomenon's come under the fold of classroom practice. The classroom practices include the relationship, interaction and communication between teacher and students for teaching and learning process.

The use of ICT in Mahendra Ratnacampus Tahachal is not different from any other campus in developing countries. The earlier studies of digital technology usage in developing countries have shown that these countries have more challenges in their ICT integration than the other developed countries. The analysis was carried out looking at the teacher's frequent use of ICT in mathematics teaching and learning. Teacher is a live researcher for his students. So, researcher interacted with teacher about the use of digital technology in mathematics teaching and learning i.e., enhance and difficulties. The data were interpreted and analyzed in the following headings:

- ) Introduction to case respondent
- ) Classroom observation of respondent students in the case school
- ) View of respondent students
- ) Math teachers view towards practice of digital technology in mathematics education
- ) Opportunities and challenging of digital technology in mathematics education.

#### **Introduction to Case Respondent**

This case study was conducted mainly in two campuses under Kathmandu valley Mahendra Ratna Campus, Tahachal and Sanothimi Multiple Campus, Sanothimi Bhaktapur. Most of the students came from different parts of the country to study there and most of the classes and communities were represented. The purpose of this study, which is based on the practice of digital technology, its opportunities and challenges is to understand what the overall situation is so that representation of many

classes, communities and places has made it more effective. The study conducted at the undergraduate and graduate level was based on special student-teacher interviews and classroom observations from both campuses. A total number of 6 students, 3/3 students and two teachers from each campus were interviewed as a sample. Pseudo names of all teachers and students were mentioned. The following respondents were taken as sample of the study.

**Om.** Om male studentis from Doti. He is 21 years old. There are six members in his family with parents and one elder brother, one younger brother and one younger sister. His parent's occupation is agriculture. His family income is not sufficient for his family. His father is literate but his mother couldn't read and write. He studied in village school in grade 10 and went to dhangadhi for his intermediate study. Now he is in Kathmandu for his bachelor's level study. He studied in Mahendra Ratna campus Tahachal at bachelor's 3<sup>rd</sup> year with major subject Mathematics Education.

He was unknown about digital technology when he studied at secondary level. While he came into dhangadhi for his intermediate level study he was little more introduced with digital technology like as YouTube, Email, Internet Computer etc. After finishing intermediate level study, he came to Kathmandu for bachelor's level study. Now he is studying in Mahendra Ratna Multiple Campus, Tahachal. He used Geogebra, Scientific calculator, Mobile as a digital technology and when he gets confused in any mathematical problem, he uses YouTube to solve it.

**Ramu.** Ramu male studentis staying in one of the houses in Balaju Kathmandu. He is from Kapilbastu districts. He is 20 years old. There are 8 members in his family including parents, one younger sister and three younger brothers. His father is a teacher and mother are house wife and also involve in agriculture. His family is middle class family. He was very good in mathematics at school level and he was always first in his class. He came to Kathmandu from Kapilbastu for higher study and studied in Janasewa Higher Secondary school, Kirtipur. Now he is studying in Mahendra Ratna campus Tahachal in bachelor's 3<sup>rd</sup> year with majoring Mathematics Education. He was unknown about digital technology when he was in village or in high school. Most of the students are unknown about use of digital technology in mathematics education. So, he was one of the students who was unknown about use

of digital technology in mathematics education. He used computer and other mathematical software when he came in Kathmandu.

**Ramu** a male student used mathematical software like scientific calculator, Spreadsheet, Mobile phone, computer etc. when he reached in bachelor level. Now days he is familiar with other digital tools which used in mathematics like Geogebra, latex and other mathematical software.

**Deepa.** Deepa female studentis from Kailali. She is 21 years old. She has 8 members in her family with one elder brother, one younger brother, one elder sister, two younger sisters and parents. Her parents live in Kailali and she is in Kathmandu. Her family is literate family father work at Nasu post in municipality and mother also work in teaching profession. Her family is middle class family and also literate so her learning environment is intuitive. She studied in boarding school upto class 10. After SLC she studied in Kailali multiple campus in intermediate level. She was little more familiar with use of digital technology in mathematics education. She used digital technology mobile phone, computer, online resources (email, internet), YouTube, other mathematical software like as photomath, GeoGebra etc.

After finishing her intermediate level, she came in Kathmandu for bachelor level education. She is studying in bachelor's 3<sup>rd</sup> year in Mahendra Ratna Campus Tahachal. Her position in class is very good. According to her classmate she was talent student in class. She uses digital technology (mathematical software) for solving mathematical problem.

**Yamuna.** Yamuna female studentis from Bhojpur. She is 21 years old and she has six members in her family. Her family background is poor. Her parent's occupations are agriculture. His parent's occupation is agriculture. Her family income is not sufficient. She studied in village school at +2 level. Her village is acute there was not electricity and internet access so shedidn't use to get digital technology in learning. She just used normal calculator as a digital technology in mathematics education. Now she studying in Sanothimi Multiple Campus Sanothimi, Bhaktapur and shelive in Sanothimi in rental. She is more interested in mathematics learning. She learned about digital technology in pandemic period of korona. She uses Goggle, Internet, Geogebra, Latex, and other digital technology in mathematics learning. She wants to be a competent teacher of mathematics.



**Sugam.** Sugammale studentis 21 years old. He is from kaski district but nowadays he is in Kathmandu. All members of his house followed the Hindu religions and speak Nepali language. His main aim in life is to be a good teacher. His interested subject is Mathematics and Science. His father is a teacher and mother are housewife. His family was middleclass family. He studied in village school at higher secondary level. He used calculator and mobile as a digital tool in higher secondary level. After finished his intermediate level study he came in Kathmandu for bachelor's level study. Now he studied in Sanothimi Multiple campus Sanothimi, Bhaktapur. He is middle class students in his class. He uses online resources, Calculator, Geogebra and other digital tools in learning mathematics education.

**Hemanta.** Hemantamale student is from Dadeldhura districts. He is 22 years old. There are seven members in his family including parents, one younger sister and two younger brothers. His father is business man and mother are house wifeand also involve in agriculture. His family is middle class family. He studied in village school at secondary level. He studied inter level education from Dhangadhi, Kailali. He just used normal calculator as a digital technology in mathematics education at secondary level and he used computer as a digital tool in higher secondary level.

After finished his intermediate level he came in Kathmandu for bachelor level education. He was studying in bachelor's 3<sup>rd</sup> year in Sanothimi Multiple Campus Sanothimi, Bhaktapur. His position in class is good. According to his classmate he is middle level student in class. He used digital technology (mathematical software) for solving mathematical problem like as photomath, online resources, Geogebra etc.

**Shyam.** Shyam is male teacher from Kathmandu district. He is associate professor of mathematics education at associated campus of T.U. in Nepal with 12years of teaching experience in mathematics and he is also the teacher of ICT in mathematics Education. He completed his schooling from the village school but did not get to use digital technology as a student.He is currently teaching on the campus of Tribhuvan University. He is also teaching ICT in mathematics education by learning self-study through digital technology. He has participated in various ICT seminars and trainings as well as presented worksheets. He also has good experience in the use of ICT and its effectiveness in teaching mathematics. He was also an author of several textbooks of mathematics for the school level and had supervised preservice teachers in their practicum.

**Prema.** She is an associate professor of mathematics education at Sanothimi Multiple Campus, Sanothimi, Bhaktapur in Nepal with 15 years of teaching experience in mathematics. She is also the students of M.Phil. degree and a few years of teaching experience in teaching school mathematics (i.e., elementary and high school). She has participated in various ICT seminars and trainings and she also organized the ICT program by zoom meeting pandemic period. She also has good experience in the use of ICT and its effectiveness in teaching mathematics. She is also the teacher of ICT in mathematics education.

### **Classroom Learning Environment of Campus**

Good environment is important factor for good learning. Classroom environment should be educational, practicable and peaceful for study. For good learning of students, campus environment should be mixture of social value, culture and education, friendly behaves, safety, practice and organized structure and physical infrastructure and access of internet is most important for use of digital technology. The relationship among administration, teachers, students, parents is also responsible for good learning school environment for students. There should be healthy relationship among teachers, students and parents. And healthy competition between students. For the practice of digital technology in education the school/campus environment must be students friendly and physical infrastructure and digital infrastructure are main factor for it.

The school environment plays an important role to decide the future position of students and their lives. The teaching activities and extra curriculum activities conducted in the school come with in the school environment. There should be rules and regulations to be followed by teachers and students to build their bright career. The sample school for these studies are Mahendra Ratna Campus Tahachal and Sanothimi Multiple Campus Sanothimi. Both of the schools are in Kathmandu valley so the school environment is safe and teachers are qualified.

Physical Infrastructure and ICT Lab is the most important for the use and practice of digital technology in mathematics education. For digitalized mathematics education digital lab should be in school. Mahendra Ratna Campus and Sanothimi Multiple Campus both lies in Kathmandu valley. Mahendra Ratna Campus is in Kathmandu district and Sanothimi Multiple Campus is in Bhaktapur districts. Both

campuses have projectors for teaching as well as ICT labs. However, due to the slowness of the net and lack of network connection, it seems that the students have difficulty in accessing the services through the net. Also due to the slowness of the net, the study seems to have been hampered due to the slow working of computer in the ICT lab.

### **Classroom Observation**

This is the qualitative research so classroom observation is the most important data collection tool for the research as interview is. To find the students participation and activities in the class about practice of digital technology, the researcher observed three class from each sample school and observed the class activities carefully. As a part of research, the researcher observed respondent students in the classroom of Bachelors 3<sup>rd</sup> year and master's degree for six days (three days in each sample campus). The classroom activities were observed according as the observation form prepared by the researcher himself consulting with supervisor (see appendix I). Among them six class observation two class observation is presented in the following episode:

#### **Episode 1**

*This class observation episode was related to Mahendra Ratna Campus Tahachal. There were 18 students in the class, among them 13 were boys and 5 were girls. There were 14 students present in class where 10 boys and 4 girls. They were scattered randomly in the class. The teacher as usual entered in the class with a greeting and the students respond him.*



*Most of time he revised previous lesson before he started the new lesson. This is the class of geometry. Teacher used overhead project for teaching as a digital tool. The teacher equally respondent the curiosity made by the students. The involvement of*

*students in teaching learning activities was satisfactory. But the use of digital tools for learning was not satisfactory. It was the third observation class of that campus. Most mathematical subjects are related to abstract knowledge and one subject related to abstract knowledge is algebra. abstract subjects are easier to understand if taught using mathematical software's Geogebra, Mathematica.*

*The researcher observed that algebra was being taught in the classroom. Although an overhead projector was connected, it was not being used in teaching. Students were taught through discussion using a student-centered method. However, it was clear from the class that it could be difficult for students to understand just by using discussing the theory. The*



*students were interested in the understood subject but in the abstract subject the students were only writing rather than reading carefully. Thus, despite the use of student-centered teaching methods, there was a lack of digital technology in teaching and learning because of abstract content.*

## **Episode 2**

*This class observation episode was related to Sanothimi Multiple Campus, Bhaktapur. There were 23 students in the class, among them 12 were boys and 11 were girls. There were 21 students present in class where 10 boys and 11 girls. It was second class observation of this class and it was in morning. All the students stood up and said good morning then the teacher told them to sit down. This*



*showed that the students were well disciplined and the campus had taught them to respect the teacher. The class was well managed. The involvement of students in*

*teaching learning activities was satisfactory because the interaction between teacher and students being well. But the use of digital tools for learning was not satisfactory.*

*The researcher wanted to check the practice of digital tools in classroom of mathematics education and also activities related to digital technology. Students had mobile phones as digital tools and some of had scientific calculators. And teacher used overhead projector and he used projector with to show the slider with slide but use of*



*figure was less. The student's conceptual understanding of the subject cannot be constructed by interpreting the geometric subject as a language only. Geometric figures presented using 2D and 3D figures make it easier for students to grasp abstract subjects, but the used of geometric figures using Geogebra, Mathematica or any other mathematical software was less when using class overhead projectors. The students did not show any interest in it. During the personal interview, the students mentioned that they were using mathematical software like GeoGebra, Mathematica, but it was not seen in the classroom.*

Overall, from above, looking at the classroom activities on both campuses as a whole, it can be seen that although students mentioned using digital technology at home for mathematical problems, its use in the classroom was not satisfactory. Due to the lack of physical infrastructure in campus, the lack of digital content, the lack of free internet for online resources, and the lack of a good network, the use of digital technology for teaching mathematics in the classroom seems to be unsatisfactory. Also, lack of skilled manpower is one of the major reasons for this. Therefore, it is necessary for the school / campus to create a digital technology-friendly environment in order to effectively teach mathematics to the students in an effective and easy way.

## **Respondents Students' View**

### **Section 1: To explore the practices of digital technology in mathematics education**

This study explores the type of digital technologies practiced in mathematics education. This study represents the effectiveness of digital technology tools in mathematics education. This study focuses on addition to requirements of digital technologies and mathematical education system such as connection between digital technology tools and mathematics contents. The practiced of digital technologies in mathematical activities creates up new opportunities, adequate methods for dissemination and management of digital technologies, development of necessary competencies on the basis of digital literacy, ensuring equitable access for all who wish to obtain necessary knowledge and decision-making skills, ensuring demand for e-learning, e-library and e-education. Appropriate use of digital technology allows mathematical learners to have the freedom of choice to decide their own time and place to study mathematical content easily. Digital technology such as laptop, mobile device, i-pad, television, radio taps, video taps, overhead projector etc. enhanced the learning efficiency and learning styles of students. In Mathematics education we can see a radical change in the range of uses of digital technologies to support teachers in the classroom and to enable students to access school work from home. If we are to make best use of the potential of such digital technologies to radically improve teaching and learning mathematics, we need to take stock of what we know now, what we have seen to work, what we would like to see tried as well as how to introduce, support and sustains the innovation required.

**Practices of Digital technology in mathematics education is divided into different themes they are as follow;**

**Practice of digital technology in classroomactivities.**School is a complicated object to study: it consists of various administrative levels, from the national policy level to classrooms; various actors, such as school staff and pupils inside a school as well as parents and local school administrators outside a school; contradictory aims, such as aiming to ensure relevant competence levels for pupils in the future, but simultaneously, carrying on the traditions and history of society. Digital technologies have been available in school mathematics classrooms since the introduction of

simple four-function calculators in the 1970s. Since then, computers equipped with increasingly sophisticated software, graphics calculators that have morphed into ‘all-purpose’ hand-held devices integrating graphical, symbolic manipulation, statistical and dynamic geometry packages, and web-based applications offering virtual learning environments have changed the mathematics teaching and learning terrain (Goos, 2021). However, our curriculum have not managed to meet all these challenges: e.g. digital technology has not yet been applied much in education. (Ilomäki & Lakkala, 2018). Classwork is a written or oral work-done in a classroom by a student. Classwork done in a classroom by the students and teacher jointly. The aim of this study was to explore the type of digital technologies used in transformative pedagogy of mathematics classroom which describes the main elements for improving education with digital technology and helps to reveal differences between mathematics and identify with their best practices. The researcher conducted interview on above topic then the respondent replied their view as following

*Om said that “Digital technology is the part of practical education. So, I used mobile phone and scientific calculator as a digital technology in mathematics. In my earlier grades I was unaware about the facilitations that can be created by technology in mathematics learning. Technological devices, especially mobile phone helped me to develop some mathematical concepts like geometrical figures.”*

*Ramu said that “Obviously, digital technology is important in mathematics classwork because it is used for drawing mathematical figures in easy way. I hope we can do more and earn more with the help of technology.”*

*Deepa said that “Yes, I used mathematical software such as Geogebra through PC to construct spreadsheet for statics. The use of the over-head projector in the classes has helped us to make concepts about mathematical abstracts. Similarly, I feel more interested in learning mathematics while our teachers use technology.”*

*Yamuna said that “Yes, I have been using digital technology in classwork such as scientific calculator for calculating mathematical problem. Calculator is faster as well as reliable. The saving of the time due to the use of calculator helps me to go further for solving another problem.”*

Sugam said that *“I have been using scientific calculator and mobile phone as a digital technology in mathematics education. I love using them but I am deprived of using it for last two months since I lost my mobile. Similarly, our colleagues are not able to get the opportunities of digital technology due to the problem of electricity, internet connection and the other factor. Moreover, some schools are also facing the same.”*

Hemanta said that *“We have been using laptop, projector, calculator, scientific calculator and mobiles in mathematics classwork. Me myself prepare slides for my presentations thinking that figures presented with the help of technology bring more learning outcomes in quicker way. This all is possible because of 3D representation of presented figures.”*

From the above interview the researcher concludes that digital technology is the most important part of mathematics education. Digital technology can foster and improve the skill of using ICT to solve problems, which is important for students. Research shows that people who can solve problems using ICT have higher chances of being employed, and even earn more than people without ICT experience. Meaningful digital homework encourages students to think through what they are learning and enriches their experience using ICT. Most of the students use digital technology as their mathematical guide but our colleges are not able to give the opportunities of digital technology due to the problem of electricity, internet connection and the other factor. Therefore, we need to draw the attention of the concerned bodies to expand the access to electricity and internet in the campuses / schools and we must join hands for that. Similarly, students feel easy to understand different abstract mathematical concepts in easy way with the help of 3D representations of the figures on overhead projector. Students feel interested in learning mathematics while their teachers used technology in classrooms.

**Practice on online resources.** Any resources available on the internet and google for teaching and learnings are online resources. The internet and google are the most popular online resources for mathematics learning. A very significant part of this research work focuses on to give the information about digital technology in mathematics education and to inspire for the online resources. Online resources are Internet-based equivalents of more conventional curriculum resources: books, articles, pictures, movies, games, google, email. Formats include web



documents, audio files, images, videos, animations, word processing documents and others. Existing research on the use of online learning resources reveals that it improves students' achievements and faculty performance. For example, they can transform the lecturer's role from information provider to facilitator and make students more independent learners. Online resource changes the habit to depend only in bookiest knowledge.

About this criteria researcher tried to find out the view of different respondents, the respondent replied their view as following:

Om said that *“I use online materials to learn different mathematical knowledge, to solve mathematical problems that confuse me, to search for different mathematical subjects. Devices allow me to search new mathematical concepts in google as well as in You Tube.”*

Ramu said that *“I use online resources to prepare power-point slides for presentation. Power points are not only attractive but also faster and long lasting. They also include more concepts about mathematical problems within a single picture/ slide.”*

Deepa said that *“Online resources are the best sources to learn varies mathematical knowledge. So sometimes I use online resources to practice the mathematical concepts at home too.”*

Yamuna said that *“Obviously I use online resources to learn about mathematical history, to search confusing mathematical problem but due to the problem of internet we are unable for regular uses.”*

Sugam said that *“Yes I use online resources like as books, articles, pictures, movies, games, google, email in learning mathematics to get knowledge. Technologies are easier to be ported than textbooks”*

Hemanta said that *“Because of using online resources many problems can be solved related to mathematics education. So, I use online resources to confirm my knowledge. I don't need teachers to correct myself because proper use of technology does so.”*

From the above argument the researcher argued that mathematics learners are practicing online resources in their daily mathematical learning. It is clear from the

interview that students are clear about online materials in math education. Students want to make full use of online resources for mathematics education, but many places in our underdeveloped country do not have internet access, lack electricity. So, students have problems using online resources. However, based on the participants in the interview, it can be said that the students are using online resources. They use online resources not only to search new mathematical concepts but also to correct themselves/ confirm their knowledge. Students feel technology as more portable than textbooks. Students believe that power points are not only attractive but also faster and long lasting. They praise the use of technology because digital devices demonstrate many concepts about mathematical problems within a single picture/ slide in easier way.

### **Practice of mathematical software GeoGebra and**

**Mathematica.**Mathematical software is the software used to analyze or calculate numeric, symbolic or geometric data. It is a type of application software which is used for solving mathematical problem or mathematical study. Geogebra and Mathematica are the most popular software for solving problem and study of mathematics. They are dynamic mathematical software for all levels of education that brings together geometry, algebra, spreadsheets, graphing, statistics and calculus in one easy-to-use package. GeoGebra is a rapidly expanding community of millions of users located in just about every country. GeoGebra has become the leading provider of dynamic mathematics software, supporting science, technology, engineering and mathematics (STEM) education and innovations in teaching and learning worldwide. And Mathematica is a symbolic mathematical computation program, sometimes called a computer algebra program, used in many scientific, engineering, mathematical, and computing fields.

When I collected the perceptionsof various respondents about its use, all my respondents said:

*Om said that “Geogebra and Mathematica are dynamic mathematical software, they are very helpful for our teaching so I use both of them software. Butour schools and universities are less focused toward these things.”*

*Ramu said that “I was unknown about Geogebra and Mathematica before the pandemic period of Covid but now days I use Geogebra for geometrical*

*problem and sometime I use Mathematica also. These both software is very helpful for solving and understanding mathematics education.”*

*Deepa said that “I know about Geogebra but I don’t know about Mathematica and I have not used. But I want learn mathematics and develop the conceptual understanding by the use of Geogebra and Mathematica.”*

*Yamuna said that “Mathematical software makes easy to mathematical problem but I have not used because I have not laptop but I used photo math, free formula apps and other apps related to mathematics.”*

*Sugam said that “Sometime I used Geogebra for solving mathematical problem like as geometrical 2D or 3D figure and other also. The utilizing Geogebra in learning mathematics has several positive impacts, including: Geogebra is a great tool to improve the quality of learning, particularly to explore, visualize, and construct mathematical concepts”*

*Hemanta said that “Obviously I use mathematical software Geogebra, Mathematica and other tools also for mathematical problem. I think Geogebra and Mathematica are very helpful software for us to make mathematics easy. In mathematics classroom, ICT can help students and teachers to perform calculation, analyze data, explore mathematical concepts thus increasing the understanding in mathematics”*

According to above respondent view most of the students who studied in higher level use mathematical software Geogebra, Mathematica and other also. And today is the era of digital technology so most of the students are familiar with digital technology. But we are citizens of underdeveloped countries and we have many difficulties in using digital technology such as lack of internet access, lack of digital content etc. So, most students are still out of reach. The situation of students studying in other parts of the country can be easily estimated as even the students studying in the capital of the country like Kathmandu Valley do not have access to technology. Therefore, emphasizing the use of digital technology to facilitate learning is also indispensable today.

### **Respondents Teachers View**

**Policy and provision for ICT (digital technology) in mathematics education.** The education system of Nepal has also been influenced by the changes

made by ICT in the global context. The Government of Nepal, Ministry of Education, through National Curriculum Framework (NCF), has introduced ICT as a subject as well as ICT as a tool for instruction in school education. Many policies and programs have been introduced to make education technology friendly, including ICT master plan (2013), information and communication technology policy (2072). Various policies and programs related to information and communication technology have been introduced in education but the implementation side seems to be weak and digital technology is still not familiar in education in various fields (Dhital, 2018).

In this topic the researcher includes the interview of sample teachers related to policies and provision related to digital technology. In this perspective when researcher asked about the View on the Policy and provision for ICT (digital technology) in mathematics education to the teacher they replied as accordingly

Shyam, associate professor at Mahendra Ratna Campus, Tahachal said that *“Education has been considered as a fundamental right of the people by the Constitution of Nepal 2072. Nepal has developed and implemented numbers of policies and programs provision that heavily emphasis on ICT on education, like National IT policy (2010, 2015), 10th plan (2002-2007), Three Years Interim Plan (TYIP, 2007-2010, 2010-2013), School Sector Reform Plan (SSRP, 2009-2015). The Government of Nepal (GON), Ministry of Education (MOE) has introduced various interventions in order to achieve the goal of education in Nepal. Use of Information and Communication Technologies (ICT) in education has been considered as one of the strategies to achieve the broader goals of education. The Government of Nepal, Ministry of Education, through National Curriculum Framework (NCF), has introduced ICT as a subject as well as ICT as a tool for instruction in school education. The implementation of the Information and Communication Technology in Education Master Plan (2013-2017) has increased access to computers and the internet in schools, which allows for the scaling-up of the use of ICT in school education. Although many policies have been introduced in the field of information and communication technology, the policies and plans related to information and communication technology have not been meaningful due to the inability to implement them effectively. Therefore, it seems necessary to focus on its implementation.”*

Prema, Sanothimi Multiple Campus, Bhaktapursaid that “*The initiation for ICT in school education is progressing. The implementation of the Information and Communication Technology in Education Master Plan (2013-2017) has increased access to computers and the internet in schools, which allows for the scaling-up of the use of ICT in school education. The recent national educational plan School Sector Development Plan (2016–2023) integrates and focuses on use of ICT in government schools. This demonstrates the commitment on the part of the government. Until now, the program is not in a stable position. The roadmap has been clear but the travel still takes a long time. The use of digital technology in education is very important and the use of digital technology in mathematics education is even more important. Therefore, in order to make learning effective and practical, it is necessary to make the school a technology-friendly school with the provision of skilled manpower.*”

We conclude from the above interview that the integration of digital technology helps teachers, educators and researchers with many facilities in field of mathematics. The potential of ICT for learning and teaching, and the factors are decisive in making it work in the mathematics classroom easily. This leads to the conclusion that crucial factors for the success of digital technology in mathematics education include the design of the digital tool and corresponding tasks exploiting the tool's pedagogical potential, the role of the teacher and the educational context. The teachers praised the provisions envisioned in Information and Communication Technology in Education Master Plan (2013-2017), National IT Policy (2010-2015), SSDP, SSRP, Constitution of Nepal -2072, etc. These all provisions focus as well as aim to provide access to ICT use for all students. Though they admire the policies, they are worried about the situation that there is no crystal-clear roadmap for implementing policies. The use of digital technology in education is very important and the use of digital technology in mathematics education is even more important. Therefore, in order to make learning effective and practical, it is necessary to make the school a technology-friendly school with the provision of skilled manpower.

**Opportunities and challenges of digital technology in mathematics education.** Digital technology in Education means teaching and learning by the use of digital technology. Digital technology is currently being used in education to assist students to learn more effectively by providing teachers with access to a wide range of new pedagogy. These technologies are also being used to enable teachers to do

administrative tasks more efficiently. Digital technology can complement, enrich and transform education for the better.

The researcher can argue that practicing of digital technology is necessary for all learner to improve their reading and learning capacity. This also develops confidence level of student in learning mathematics. This develops an alternative way for learner to read mathematics content at any time and at any place. In this perspective when researcher asked about the View on the opportunities and challenges of digital technology in mathematics education to the teacher then he replied as accordingly

Shyam, associate professor, Mahendra Ratna Campus, Tahachal said that *“Digital technology plays vigorous role to make mathematics teaching learning activities more meaningful. In my views Digital technology is a basic understanding tool to motivate students and to provide some sense of how we can create this motivation. Our ideal goal as teachers is to help students develop the intrinsic motivation that will allow them to become lifelong learners, respect students as learners and engaging students in the class and working with their peers is an important contributor to student learning. There are much such types of abstract, which we can, unable to demonstrate. So, digital technology gives such opportunities to simplify the abstract ideas and promote a good environment. An example from Geometry, ‘when two parallel lines are cut by a transversal, the pairs of alternate interior angles are equal’. Now the statement is in abstract form but if the learners gate opportunities to learn by using Digital tools, then they can realize and visualize that otherwise it may be only in abstract and drill memorization learning. This is a crucial example of abstract knowledge to visualizing and realizing by using Digital tool (GeoGebra). In past decades, mathematics teaching is just transmission of knowledge from head-to-head and there is not any question. What sort of quality is promoting over but Digital technology is a tool, which alerts the quality of teaching in the scenario of world context? But at the same time there may be many challenges for practice in mathematics education in the context of Nepal. In our context, we are facing various problems and challenges for using Digital technology in mathematics classroom or in other subjects. Geographically we have Terai region, Hill region and Mountain region. In Mountain region very difficult to manage the basic requirement like as electricity, transportation, network due to weather etc. for using Digital*

*technology than Terai and Hill region. Terai region somewhere the learners and facilitators get opportunities to use Digital tools in classroom activities but not so in Hill and Mountain. Therefore, we are facing as challenge to use ICT in the school and university level likewise in Mountain, Hill and Terai region.”*

Prema, associate professor at Sanothimi Multiple Campus, Bhaktapur Said that *“Teaching mathematics with digital technologies is a challenge that teachers in different countries have faced to differing degrees both individually and as practitioner communities. In most of the developing country has economic challenge to use Digital technology in classroom activities as same as in Nepal. Therefore, the gigantic challenge for Digital technology is economic disasters. After Covid-19, we teachers are also taking digital tools as our facilitators too. We realized its importance. Some of use developed our skills of technology use only after Covid-19. Some teachers themselves are facing problems in using digital technology. They are in dire need of trainings. Awareness and positive attitude towards technology is widely recognized as a necessary in mathematics for interactive teaching, learning activities. All Nepalese pupils and facilitators may not have such types of awareness and if some conscious about it but they do not try to develop as an attitude for using Digital technology in mathematics classroom. These are the hidden challenge that we are facing now a day. The main challenges of our colleges to use digital technology is lack of ICT proficient course facilitator. And also, the ICT infrastructure and internet access in rural areas. So far, ICTs have not been used as a way of acquiring new knowledge and skills in schools of Nepal due to inadequacy of curriculum content and limited access to ICTs. Other challenges include inadequate funding, lack of basic infrastructure, lack of qualified personnel and lack of policy formulation and implementation. In the same time there are many opportunities of digital technology in mathematics education if we reduce these problems related to use of digital tools in teaching and learning of mathematics education. The Digital technology program serves as a catalyst for an improved and effective learning environment in mathematics classroom. Digital technology is flexible tools to meet the learning needs of students and compliment an enriched learning environment managed by the classroom teacher. Through its use, the efficiency and effectiveness of learning can be improved.”*

From the above interview the I concluded that there are many challenges and opportunities to use of digital technology in mathematics education. Both teachers thought that the digital technology increases intrinsic motivation for learning more mathematical concepts. Technology also encourages for lifelong learning. They noticed that the use of technology in teaching and learning mathematics is more flexible which meets every individual's interest that ultimately results more understandings of abstract ideas. Moreover, they say abstract ideas are simply understood with the help of technological devices. Digital technology provides great opportunity for schools/universities in developing countries to improve their teaching and learning processes. The both teachers agree that the geographical diversities in Nepal have become the challenge to use technology in teaching and learning. Other challenges include inadequate funding, lack of basic infrastructure, lack of qualified personnel and lack of policy formulation and implementation. Moreover, one of the teachers stated that consciousness toward the use of the digital technology in teaching mathematics as a hidden challenge. Therefore, before implementing the ICT familiar curriculum in school to university level, the Ministry of Education Nepal, Curriculum Development Centre and other related sectors need to think for removing the challenges that we are facing. Therefore, it seems necessary to take initiatives from various fields for making mathematics teaching and learning technology friendly and for simple and meaningful learning of mathematical abstract subjects.



## Chapter V

### Findings, Conclusion and Implications

This chapter deals with major finding drawn from the study after the analysis of collected data. The area of recommendation is also included for the further study.

#### Finding of the Study

The specific objectives of this study were to explore the practice of digital technology in mathematics education and to analysis of opportunities and challenges using digital technology in mathematics education. Use of Digital technology in mathematics class increase the interest of students, it contextualizes the content, visualize the content in mathematics education. Motivating the students is one of the challenging tasks for the teachers in Nepal, it visualizes the content so that the classroom becomes more interactive and interesting, and it also connect the classroom with the international collaborative partner classes as well. Different mathematical software, You Tube videos and other internet site could help students for the conceptual learning, it refers our students for the self-learning and also connect the teachers from the worldwide in a moment, due to the process and the learning ability in the mathematics digital technology motivate the students in learning. Digital technology tools support visualization of mathematical concepts in various ways of expressions, and as such may foster versatile thinking, especially when these representations are dynamically linked. Digital technology tools have a positive impact on mathematics students learning. Digital technology tools cause students to be more engaged, thus student get more information. Because of the arrival of new technologies tools in mathematics rapidly occurring globally, technology is relevant to the students. Digital Technology tools provides meaningful experiences to mathematics student including mathematics, reading and research.

To meet the objectives of the study, Mahendra Ratna Campus and Sanothimi Multiple Campus in Kathmandu valley were visited for a week-long to collect data. Case study approach among qualitative research design method was adopted for this study. The data were collected through interview schedule and classroom observation forms. Two mathematics teachers and six mathematics students of Bachelor and master's degree were selected as the purpose of the study. Literature on mathematics

teaching and learning shown that there is a general consensus on the need to enforce in our student's problem solving and high order thinking skills in mathematics so that they can be captured in pursuing successful careers. Digital technology helps the students to become more active in the education process. So, the connection of digital technology with mathematics students are very deep. The researcher found that the students enjoyed 3D figures to make conceptual understandings of even abstract mathematical contents as George Siemen and Stephens Downs (2009) stated in their theory of connectivism as a digital technology. As connectivism focused on realistic and interactive learning, the sampled students also perceived figures in natural language through their mental interaction, which is called connecting mathematical language to natural language. Students felt easier to make conceptual framework of mathematical abstract contents with the help of geometrical figures generated from Geogebra. The major findings of the study were;

- ) This study found that the students of higher level are going in the digitalization.
- ) The digital environment of school and universities is not satisfied but at the same time development of digital learning is going on growth.
- ) Various policies and provisions have been formulated for the development of technology in teaching and learning but its practical implementation is going slowly.
- ) Student's involvement in the sector of digital world is satisfactory.
- ) The physical environment of campuses for using digital technology seems to be weak. But in some cases, teacher seem less interested in using technology even when they have access to it.
- ) Campuses are equipped with overhead projectors for technical education, but they have not been used effectively.
- ) For technology-friendly teaching and learning there are many opportunities along with challenges.
- ) Technologies are used by students to confirm their knowledge in the absence of teachers. Which is a good opportunity of students for self- learning as well as life- long skills to learn.
- ) Students enjoyed power-points which made interesting and long-lasting learning.

- ) The study found that students wanted to learn mathematics worldwide by the use of digital tools.
- ) The study found that the awareness about digital technology is needed. At the same time the awareness about technology works as the intrinsic motivation for the learners to learn mathematics.
- ) Students feel digital technology as more flexible tool to learn in their own pace as well as interest.
- ) The portable quality of digital tools and technology have made it more preferable.
- ) The teachers praised the quality of digital tools to carry many concepts within a single picture/ figure.
- ) Some teachers themselves are facing problems in using digital technology. They are in dire need of trainings
- ) The challenges faced by teachers to use digital technology are more related with school environment and infrastructures.
- ) Geographical variation has been bringing variation in the use of digital tools. For example, Himalayan region is out of reach of electricity as well as internet whereas Terai does have access to these things.
- ) Despite the facilities in schools or teachers' skills to use digital technology in classrooms, some students have their personal problems. The problems be like; lack of devices as Sugam, one of the respondents faced.

### **Conclusion of the Study**

The major finding of the study shows that the use of digital technology in mathematics learning is increasing day by day. Mostly, mathematics students are practicing digital technology in mathematics education. There is a growing concern in students and teachers of mathematics about teaching mathematics by using digital technology. This study was case study. The researcher himself developed questionnaire under the guidance of supervisor. The questionnaire, classroom observation and interview schedule were main tools of this study. The responses were collected from mathematics students from Mahendra Ratna Campus and Sanothimi Multiple Campus, selected by purposive sampling method. Open questionnaire was included in each category of problems, and descriptive analysis of collected responses were carried out. The triangulation method was used for the analysis and such

analysis was authenticated by qualitative data obtained by class observation form and interview schedule. Therefore, the participants' views about digitalization of mathematics education for empowering and promoting digital technology in mathematics teaching and learning signified the need for teacher motivation, integration of mathematics concepts. And also, digital technology provided great opportunity for schools/universities in developing countries to improve their teaching and learning processes. Higher level students of mathematics have been connected with digital technology and they wanted to use technology for teaching and learning practice of mathematics education. Although students and teachers wanted to use digital technology for effective learning of mathematics, the physical infrastructure of the school and the environment of technology-friendly learning were not so comfortable. There are many challenges and opportunities to use of digital technology in mathematics education. For the conceptual development of mathematical abstract subjects, the learning is being more effective through digital technology. There was limited use of digital tools in education before the COVID-19 while from the perspective of positive glance, pandemic boosted use of digital platform encouraged schools, and higher education institutions when closed their face-to-face classes due to the nationwide lockdown. While the medium of learning before covid-19 is physically confined to schools and universities, various digital platforms for post-covid-19 learning have emerged as technology-friendly learning. If education can be made technology friendly and schools and universities that are blocked for various reasons can be run smoothly, then education can be made more dynamic. Therefore, the use of digital technology in education is a necessity today.

In the conclusion practice of digital technology in mathematics education is increasing day by day. The use of technology in teaching and learning has so many challenges as well as opportunities. Getting access to flexible tools, portable sources of information, multiple concepts carried by single figure, and representation of abstract concepts by digital tools really help for lifelong learning skills. All the students and teachers of mathematics know about the effectiveness of digital technology. But at the same time the physical infrastructure of campuses is not satisfied. Therefore, we need to increase the use of digital technology in mathematics learning to make learning effective, the physical infrastructure of the campuses, the

provision of free Wi-Fi, as well as the effective implementation of policies and provisions.

### **Implications**

On the basis of finding of this study some measures have been implemented for increased use of digital technology in mathematics education the following study should be carried out in order to make the result of the study complete

- ) Students want to learn mathematics worldwide, so the expansion of digital technology is necessary.
- ) The further researches can touch guardians' perspectives and it would help roles digital technology in mathematics education be student friendly.
- ) In order to make mathematics technology-friendly, the school environment should be made technology-oriented along with the home environment.
- ) Government and non-government sectors should be able to take necessary initiatives to develop schools and universities as free Wi-Fi sector.
- ) Practical aspect with ICT integration must be included in mathematics examination not only theoretical aspect.
- ) Various policies and provisions have been formulated for the development of technology in teaching and learning but its practical implementation is not satisfactory, so it is necessary to emphasize in the field of implementation.
- ) Campuses are equipped with overhead projectors for technical education, but they have not been used effectively, so it is important to focus on the development of skilled manpower in all areas.
- ) For technology-friendly teaching and learning there are many opportunities along with challenges so we must focus on implementing the opportunities while facing the challenges.
- ) In order to connect mathematics with technology, various national and international seminars and workshops should be organized and students should be involved in it.
- ) Emphasis should be placed on technology-friendly learning from the school level.
- ) The findings of the research would help to carry dig out the gaps for further researches.

- ) The research suggests for improvement at both policy level and practice level. Even though we have policies, we are not implementing them. So implementable policies must be made and should strictly be followed.

### **Recommendation for the Further Study**

Research on a large scale is needed to see if the finding of this investigation can be generalized to other such type of studies. The researcher has made following implication for further study

- ) Similar study can be carried out with large sample size and various schools of different parts of Nepal.
- ) Similar study on the basis of class wise and other level wise can be conducted.
- ) Same study related to the practice of digital technology in mathematics can be conducted in large sample.
- ) The learning and comprehension abilities of students who use technology in mathematics education and do not use can be studied in detail.
- ) The hardships, challenges, and opportunities faced by teachers and students can be studied separately in details.

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## APPENDICES

### APPENDIX-I

#### Learners Interview Guideline

1. Students Name
2. Students Age
3. Students Gender
4. Students Grade
5. Do you have a computer at home?

Yes                      No

If yes, is the computer connected to the internet?

6. Do you use your computer or any other digital tools at home for your schoolwork?

Yes                       No

If yes, please explain what type.....

The main question of the research was an investigation of practice of digital technology and opportunities and challenging of digital technology in mathematics education. In order to get answer of this questions were asked:

1. How digital technology is being practiced in classroom activities?
2. What are the opportunities and challenges of using digital technology in mathematics?

This question was further subdivided into the following sub questions

- i) What is the current status of ICT infrastructure in your college?
- ii) What is the state of internet access in your college?
- iii) Do you use online resources for the practice of mathematics education?
- iv) Do you use mathematical software Geogebra & Mathematica in mathematics education?
- v) Which mathematical software do you use the most in the study of mathematics education and why?
- vi) What are the policies and provisions related to the use of digital technology?
- vii) What are the opportunities and challenges of using digital technology in mathematics education?

## **APPENDIX-II**

### **Teachers Interview Guideline**

1. Name of the teacher
2. Temporary Address
3. Campus Address
4. Teaching experience
5. Training

### **Topics**

1. Policies and provisions related to the use of digital technology in mathematics.
2. Opportunities and challenges of using digital technology in mathematics education.

## **APPENDIX-III**

### **Observation Checklist**

Observation checklist for classroom interaction

1. Physical Features
  - a. Computer lab
  - b. Lighting in the lab
  - c. Projector in classroom
  - d. Wi-Fi network
2. Use of Digital technology in class
  - a. Media and technology that is specific to the content area
  - b. Include integrated teaching and learning experiences using internet and other technologies
  - c. Provided opportunities for learners to use the internet as a source of information
  - d. Integrate the internet to stimulate real world problems