PRACTICES OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) IN MATHEMATICS TEACHING

A

THESIS

BY

RAJESH BAJGAIN

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Letter of Certificate

This is to certify that **Mr. Rajesh Bajgain,** a student of academic year 2072/073 with Campus Roll 61/2072-073, thesis no.1621, Exam Roll No.7228362 and T.U Registration Number 9-2-257-45-2011 has completed his thesis under the supervision of Tika Ram Pokhrel during the period prescribed by the rules and regulation of Tribhuvan University, Nepal. The thesis entitled, **"Practices of Information and Communication Technology (ICT) in Mathematics Teaching"** has been prepared based on the results of his investigation conduct during the period of 2078/079. I hereby, recommend and forward that his thesis be submitted for the evaluation as a partial requirement to award the Degree of Master of Education.

…….

Prof. Dr. Bed Raj Acharya

Date: 21 April, 2022 (Head)

Letter of Approval

This thesis entitled **"Practices of Information and Communication Technology (ICT) in Mathematics Teaching"** submitted by Mr. **Rajesh Bajgain** in the partial fulfillment of the requirements for the Master's Degree in Education has been approved.

Viva Voce Committee	Signature
Prof. Dr. Bed Raj Acharya (Chairman)	……
Prof. Uma Nath Pandey (External)	……
Tika Ram Pokhrel (Supervisor)	……...

Date: 22 May, 2022

Recommendation for Acceptance

This is certify that **Mr. Rajesh Bajgain** has completed his M. Ed. Thesis entitled **"Practices of Information and Communication Technology (ICT) in Mathematics Teaching"** under my supervision during the period prescribed by the rules and regulation of Tribhuvan University, Kirtipur, Kathmandu, Nepal. I recommend and forward his thesis to the Department of Mathematics Education to organize final viva-voce.

Date: 20 April, 2022 …….

Tika Ram Pokhrel

(Supervisor)

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Defense date: 22 May, 2022

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DEDICATION

This thesis honestly dedicated to my parents **Laxmi Bajgain** and **Uddhab Prasad Bajgain,** all my relatives, family and friends who support me in every situation of my life.

DECLARATION

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

…….

Rajesh Bajgain

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……..

Rajesh Bajgain

ABSTRACT

Practices of Information and Communication Technology (ICT) in Mathematics Teaching are an emerging field of mathematics education in Nepalese scenario. The main objectives of this study were to explore the present ICT practices in secondary school, the challenges encountered by teachers in ICT enabled pedagogy, and also to cope the challenges for promoting ICT integrated teaching in schools. This study was based on case study design of qualitative research. This study was based on a school of Lalitpur district. Two mathematics teachers who used ICT enabled pedagogy and eight students from Shree Magar Gaun Secondary School, were selected purposively. I used interview, focus group discussion, and document analysis as techniques for data collection. This study was on the basis of Vygotsky's social constructivism.

Analyzing and interpretation of data using Thomas (2006) general inductive approach, I found that ICT enabled pedagogy supports students for conceptual learning and allows visualization of mathematical concepts which helps students to link mathematical concepts in real life situation. Inadequate presence of ICT infrastructure, geographical intricacy cause problems to electricity, poor connection of internet, less technical supports, less opportunity of ICT related trainings, not enough leisure time in school, not inclusion of ICT in curriculum of mathematics challenged in ICT enabled pedagogy. ICT integrated pedagogy should be promoted for flexible lifelong learning, to enhance learning engagement, to promote reflective learning & knowledge creation. Finally, it was concluded that from the policy level, the use of ICT should be promoted for improving qualitative achievement in mathematics.

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Chapter – I

Introduction

Background of the Study

Teaching is the process of attending to the people's needs, experiences and feelings, and intervening so that they learn particular things, and go beyond the given (Smith, 2018). Interventions takes the form of questioning, listening, giving information, explaining some phenomena, demonstrating a skill or process, testing understanding and capacity, and facilitating learning activities such as note taking, discussion, assignment writing, simulations and practice. According to Hirst (1975), teaching should involve setting out the intention of someone learning something and considering people's feeling, experience and needs. Teaching would be effective if students grasp what was taught. The teaching is a process of mutual interaction between several elements around three poles: the teacher, the students and the knowledge. In addition, we can say teaching is the process of creating a situation for learner to acquire knowledge and skills. Teaching directs and guides the learning process. It also provides activities, materials, and guidance needed by the learners. Teaching is the process of sharing of knowledge and experiences to learners to develop knowledge which is usually organized within a discipline. This is an action doing by both teachers and learners and gained different concepts and skills in appropriate learning environment. It is act of conveying information to others.

In present era synonymous as "The era of science and technology", explosion on the field of technology brought changes in various areas of our lives such as the ways of communicate, collaborate, work, use the leisure time, built the relationship etc. Present world is considered as a global village through the use of Information and Communication Technology (ICT) in different educational, political, economic and

social sectors. Now a day, we found the integration and use of technology to solve problems, almost in all situations. Due to the technological changes, the trends in teaching learning process and methods are changed accordingly. Recently, the development of ICT gradually replaces the traditional teaching pedagogy. Although, the face to face classroom interaction is getting replaced by on-line communication, traditional black or whiteboard is getting replaced by interactive whiteboard, and books or printed resources are getting replaced by on-line resources.

ICT denotes any communication devices or application that has the potentiality of producing information; can store and communicate information. These may be electronic devices such as radio, television, computer, mobile and other digital devices as well as software applications associated with these devices such as digital learning programs, voice chat and video conferencing (Rana, 2018). ICT includes diverse set of technology and technological tools used to communicate, disseminates, store and manage information. ICT is divided into two main approaches in education such as ICT for education and ICT in education. ICT for education implies the development of information communication technology for learning and teaching process while ICT in education involves the adoption of general components in practical use in teaching and learning processes (Voogt & Pelgrum, 2005; as cited in Kennah, 2016). ICT is considered as one of the pillars upon which quality education for all can indeed become a reality, because of its unique capacity to bring the world together, even the most remote and most and disadvantaged of communications (Ndongfack, 2010; as cited in Kennah, 2016). ICT in education is the mode of education which uses information and communications technology to support, enhance, and optimize the delivery of information.

In concern of mathematics, there are many technological advances being used in terms of multimedia based, internet based, and software based in teaching and learning process. Among them, general software tools allow visualizing and exploring mathematical concepts in a more flexible way, more applicable way and in more learnable way. The software that can use in mathematics teaching are Geogebra, Wolfram Mathematica, Microsoft Mathematics, Geometry Pad, Photomath, Sagemath, Maple, Maxima etc. All these mathematical software facilitate students to construct and understand mathematical concepts. From the origin, the implementation of ICT in education was to transform the traditional instructional teacher-centered endavour to a learner-centered approach with active participation of the learner coach (Voogt, 2005; as cited in Kennah, 2016). Khan Academy, Midas eClass, KULLABS, Sikai Chautari are some internet based platform that can use in mathematics teaching. As noted by Monteith (2002), by using ICT in our learning we can learn how to learn rather than learn a particular skill. The use of ICT not only can support the cognitive development of the students but also increase their motivation to learn and their interaction in learning. The implementation of ICT in schools can bring some potential benefits. However, to obtain those benefits we have to overcome its enormous difficulties. These difficulties may vary from school to school, from region to region, and from country to country.

ICT integrated pedagogy is defined as the teaching learning and environment where the students have the access of getting/ having the teacher's class presentation as learning aid at their needs with flexibility of time and space. Students can view the teachers' class presentation at their home using ICT tools they solve the assigned problems themselves (Bhattrai, 2020). This is an emerging issue for effective mathematics teaching and better shape of students in mathematics classroom. The use

of ICT in mathematics helps to transform dynamics of mathematics class, the lectures can integrated with practical way, provides resources which helps for securing contents, students intuition development, see the mathematics situations in practical way. In the teaching learning of mathematics, it is important for students to be able to imagine, construct and understand constructions of shape in order to connect them with related facts. Therefore, ICT integrated pedagogy assist students in imaging and making observation.

According to SEE Result Summary (Subject wise) (2075), among 459254 students; 10953 students secured A^+, 22165 students secured A, 29144 students secured B^+, 33295 students secured B, 36257 students secured C^+, 44147 students secured C, 52628 students secured D^+, 52778 students secured D, 171231 students secured E grades in Mathematics at SEE examination held in 2075 B.S where 6602 students were absent in Mathematics examination (NEB, 2076). This shows that almost half portion of the students who appeared in examination have secured grade below C. In this scenario, 'Is really traditional method of teaching mathematics caused for poor result on mathematics?', I would like to find out the current practices of ICT in Secondary School as well as to draw out the challenged faces by teachers who use ICT integrated pedagogy in mathematics teaching.

Statement of Problem

In context of Nepal, mathematics is included from basic level to secondary level as a compulsory subject. This shows that mathematics take place as an important subject in school education. Different technological advances were used in mathematics teaching in terms multimedia based, internet based, and software. ICT integrated pedagogy is an emerging issue for effective mathematics teaching techniques. An ICT tool helps students to develop their intuition as well as to see the

mathematical situation in practical way. ICT integrated pedagogy of mathematics teaching helps to link mathematical concepts with real life situations. Akanmu (2016) concluded that the incorporation of Geogebra and other ICT packages would improve the students' learning outcomes in Mathematics, especially on students' performance in both internal and external examinations; while their attitude towards Mathematics would also be positively enhanced. Similarly, Bist (2017) indicated that students have positive attitudes toward the use of Geogebra in the geometric construction. Moreover, the use of Geogebra not only increases student's achievement in geometry but also improves their creativity and visual thinking in geometric construction through active participation and enables students to work independently by up-rising their curiosity. The advancement of technology and its devising tools had been brought change in teaching pedagogy and started to conduct a lessons throughout the use of different software and hardware which rely on ICT.

In Nepalese context, ICT integrated pedagogy is the new trends in teaching mathematics. As stated Suryani (2010), ICT can provide a considerable benefit in supporting learning. By using technology in their learning, the students can be active learners. They will be aware of what information they need, why they need it, and how they can get that information. By ICT enabled teaching system, the students become self-managed in their learning process. ICT also can provide a way for dynamic and collaborative learning. By using internet our learning is not limited to the school hours, demographically where we are, and who our teachers are. ICT can lead us to meta-cognitive learning. Also, suggested for ICT integrated pedagogy to improve the students' learning outcomes. As a mathematics teacher we must know about the perception of students on the use of ICT in mathematics teaching. Also we have to know about the challenges faced by teacher while using ICT integrated

pedagogy especially. Different studies have been done to find out the benefits of ICT enabled mathematics teaching as well as students perceptions towards ICT enabled mathematics teaching. But little one gives their attention to explore the challenges encountered by teachers in applying ICT integrated pedagogy. Thus, I choose this "Practices of Information and Communication Technology (ICT) in Mathematics Teaching" for my study.

Objectives of the Study

The specific objectives of the study were as follows:

1. To explore the present ICT practices in secondary schools.
2. To explore the challenges encountered by teachers in ICT integrated pedagogy.
3. To cope of the challenges for promoting ICT integrated pedagogy in schools.

Research Questions

The following research questions were constructed in this study:

1. What is the present status of ICT practices in the selected secondary schools of Lalitpur district of Nepal?
2. What are the challenges encountered by teachers in ICT integrated pedagogy?
3. What kinds of measure should be used to cope challenges for promoting ICT integrated pedagogy in schools?

Justification of the Study

According to National Council of Teachers of Mathematics (NCTM) (2000), technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and students' learning. Besides these, technology supports students to develop deeper understanding of mathematics. Moreover, technology can

supports for students to investigate in every area of mathematics and allow them to focus on decision making, reflection, reasoning, and problem solving.

ICT integrated pedagogy is new trend in Nepalese context, was scaling up after "Information and Communication Technology (ICT) in Education Master plan (2013-2017)". The findings of this research have helped me personally. I have been able to find out the challenges faced by teachers while applying ICT integrated pedagogy in mathematics teaching.

In practice level, I hope that the findings help for teachers as well as those teachers who seek to use ICT integrated pedagogy for cooperating with students, School Management Committee (SMC) and school administration to reducing challenges in applying ICT integrated pedagogy in mathematics teaching. At the policy level, this study also helps to cope challenges for promoting ICT integrated pedagogy in secondary schools. And also, it is beneficial for the research level, the findings of this study would form a data bank for reference and help us an area for further educational research.

Delimitation of the Study

This study was based on Focus Group Discussion (FGD) with grade 10 students. FGD was conducted in Shree Magar Gaun Secondary School which was located in southern rural area of Lalitpur district. The perception of students was based on mensuration and geometry chapters of mathematics of grade 10. Only two mathematics teachers of Lalitpur district were included in interview and eight students were selected purposively for FGD.

Definitions of Operational Key Terms

Every study constitutes some of the key words depending upon the problem, objectives, methods etc. This study used following terms and their operational definitions as:

ICT. ICT stands for 'Information Communication Technology' refers to the technology that provides access to information through telecommunication. It includes the internet, cell phones, wireless networks, and other communication mediums.

Perception. Perception is the organization, identification, and interpretation of sensory information in order to represent and understand the presented information, or the environment. In this study perception represents knowledge, experience, cognition, concept, and comprehension about use of ICT in mathematics teaching.

ICT integrated pedagogy. ICT integrated pedagogy is associated with the effective integration of ICT along with the curriculum.

Challenges. Challenge literal means a demanding situation that requires some kind action. Challenges to ICT integrated pedagogy refers to problems that come while practicing ICT integrated pedagogy in mathematics teaching.

Chapter – II

Review of Related Literature

This chapter includes the different features of article and finding of different researches in the field of mathematics education especially related to ICT integrated pedagogy for mathematics teaching. This chapter deals with the works carried out in the area of this research project, theories and interpretation were found. The literatures that are reviewed are previous related theses, books, journals, articles, and internet resources which help to researcher to add ideas for research. The purpose of the literature review was to cited previous research related to ICT integrated pedagogy in mathematics teaching as evidence in my study, to study different research which is related to ICT in mathematics teaching, to identify inconstancies gaps in research and at last analysis & interpret the data by using a theoretical and conceptual framework.

Review of Policies on ICT in Education

The constitution of Nepal (2015) has guaranteed the right to education as a fundamental right. Nepal has developed and implemented numbers of policies and program provisions that heavily emphasis on ICT in Education like Information Technology Policy (2000), National Information and Communication Technology Policy (2015), ICT in Education Master Plan (2013 – 2017), School Sector Reform Plan (SSRP) (2009-2015), and School Sector Development Plan (SSDP) (2016-2023).

Information Technology (IT) Policy (2000) firstly introduces information technology in Nepal. It stated that IT should be used to improve quality education. It also includes strategy that computer education in curriculum from the school level. IT Policy was revised in 2010 with the provision of expanding the access of internet to all schools with collaboration and coordination of both governmental and non-governmental organizations so that skilled human resources can be produced for

quality and relevant education (Joshi, 2017). School Sector Reform Plan (SSRP) (2009-2015) was implemented and expands ICT associated teaching learning strategies in school and to develop ICT infrastructures in schools (MOE, 2009).

Before 2013, the use of ICT in education has been mentioned in various policy documents related to IT, e-governance and education. ICT in Education Master Plan (2013-2017) was the first separate policy related to ICT in school aimed to expand equitable access to education, enhance the quality of education, reduce the digital divide and improve the service delivery system in education (MOE, 2013). It serves as the cornerstone from government side to identify the need for "explicit ICT in education policy in Nepal". This Master Plan focused on four major components on ICT in education program: (i) ICT infrastructure including internet connectivity, (ii) human resources development, (iii) digital content development and, (iv) education system enhancement.

National ICT Policy (2015) has developed by Ministry of Information and Communication took ICT as the means for quality education and gave priority to the development and integration of ICT in education system, e-learning, ICT based teacher training, use of computer technology in classroom teaching and learning process and development, deployment and utilization of electronic based distance education, training and education system (MOIC, 2015). Similarly, 15th periodic plan (2019/20-2023/24) took policy for development of digital learning materials to assist the teaching and learning process, especially for English, Mathematics, Science and technical subject to ensure quality in education.

The School Sector Development Plan (SSDP) (2016-2023) presents ICT as an integral part of school education where each subject curriculum is supposed to have supported with ICT. The plan has been focused on (i) the appropriate use of ICT to

improve pedagogical practices, (ii) development of instructional materials, human resources and integration of technology in curriculum and (iii) the use of ICT for the improvement and increased effectiveness and efficiency of overall educational governance and management (MOE, 2016).

Procedure for setting up a Laboratory of Information Communication Technology (ICT) in a Community School- 2076 aimed to expanding the information and communication facilities at the school by extending internet facilities at the school level. According to this, under ICT grant school should be set up ICT labs including 8 computers, 1 laptop, 1 printer, 1 photocopy machine, 1 scanner, 2 multimedia speakers and 1 LCD projector.

The use of ICT in education has been mentioned in various policy documents related to IT and education, the use of ICT in education has been recognized as the main medium for preparing the human capacity required in the use of ICT in development, and in building the country into knowledge based society.

Review of Empirical Literature

Some books, journals, thesis, articles related to ICT in mathematics teaching were reviewed and a brief introduction is given below:

Aydos (2015) did a research entitled "The impact of teaching mathematics with Geogebra on the conceptual understanding of limits and continuity: the case of Turkish gifted and talented students", whichh aimed to investigate the impact of teaching limits and continuity topics in Geogebra-supported environment on students' conceptual understanding and attitudes toward learning mathematics through technology. This study consisted of 34 students studying in a unique high school for gifted and talented students in Turkey. This study followed a pre-test post-test controlled group design. This study found that student attitudes towards learning

mathematics through technology improved, as well. The researcher concluded that Geogebra may be an effective tool for teaching calculus to gifted and talented students.

Sapkota (2015) did a research on "Effectiveness of information communication technology integrated pedagogy at secondary level", with the aim to find the effectiveness of information communication technology integrated pedagogy in the existing educational system among students in the experimental and control group of grade IX. 46 students, of two public secondary school of Kathmandu district were selected for the study. She concluded that information communication integrated pedagogy brings the effective result in terms of the achievement of mathematics in comparison to the existing pedagogy as well as student taught by ICT integrated pedagogy (ICTIP) are more motivated towards mathematics instruction.

Acharya (2015) carried out a research on "Effectiveness of Geogebra software on mathematics achievement", with the aim to find the effectiveness of Geogebra software on mathematics achievement. The researcher adopted the pretest – posttest non-equivalent control group design among students of grade10. 28 students of Panga Secondary school and 25 students of Janasewa Higher secondary school were selected for the study. He concluded that Geogebra software has a positive impact on student's achievement in the topic Circle as well as students have positive perception on Geogebra software in terms of enthusiasm, confidence and motivation.

Sherpa (2016) conducted a research on "Effectiveness of Geogebra in teaching Geometry", with the aim to find the effectiveness in teaching geometry using Geogebra in the existing educational system among the students in the experimental and control group of grade VIII. The research was based on a constructivist view of learning. The researcher adopts the pretest – posttest experimental design. 40 students

of grade VIII with teacher of Kathmandu were selected for the study. He concluded that use of Geogebra in teaching geometry is effective rather than teaching in conventional method.

Barai (2017) conducted a research entitled "Perceptions of students on the use of Geogebra in geometry teaching", with the aim of exploring the perception, participation, and motivation of students on the use of Geogebra in geometry teaching at secondary level. He used experimental research design whereas mixed method for data collection based on constructivist view of learning.22 students of Mangal Higher Secondary School were participated in this study from Kathmandu district. He finds that students had positive perception toward using Geogebra, learning was interactive and collaborative, increasing participation in classroom activity. He concludes that Geogebra software need to be used for geometry teaching at secondary level.

Kandel (2018) did his master's degree thesis on "Effectiveness of Geogebra on students' achievement in analytic geometry at secondary level". The purpose of this study was to investigate the effectiveness of Geogebra on students' achievement in analytic geometry at secondary level. He used non-equivalent pretest-posttest (quasi- experimental) research design on the theoretical basis of Vygotsky's social constructivism. 67 students of two schools of Kathmandu valley were selected for the study where 35 students were in the experimental group and 32 in control group. His findings indicated that experimental group performed significantly better than that of control group. He concluded that the use of Geogebra is very effective on students' achievement in teaching analytic geometry at Secondary level.

In the above empirical review of literatures, it seemed that many research works were concerned to the effectiveness of Geogebra software pointed out that the Geogebra was effective tool for mathematics teaching whereas few concerned with

perceptions of students towards use of Geogebra in geometry instruction up to grade nine but these study did not concern the perceptions of grade 10 students towards the use of Geogebra in geometry instruction. Also no one concern with the challenges encountered by teachers while using ICT enabled teaching. Therefore, I selected students of grade 10 for FGD and mathematics teachers for interview to find out the challenges encountered by teachers on ICT integrated pedagogy.

Review of Theoretical Literature

The purpose of theoretical literature review is to concretely examine the corpus of theory that has accumulated in regard to an issue, concept, theory, phenomena. It helps to establish what theories already exist, the relationships between them, to what degree the existing theories have been investigated and to develop new hypothesis to be tested. This section overall deals on the connection of the theory with research questions, research objectives and researcher's intuition and understanding towards the theory. As this section overall deals about how the established theory is tasted using ICT enabled teaching and learning, in this research, I draw upon the constructivist theory specially based on Vygotsy's socio-cultural cognitive theory for the cognitive development of the students.

Constructivism. Constructivism holds that there is no knowledge that exists outside of the person, there is no objective reality. We cannot assume that two people understand that in the same way. Knowledge is a process of developing understanding of something in a very personal way through situated activity (Dfty & Jonnassen, 1992, as cited in Acharya). According to constructivism neither the human experience nor the pre-existing structure related to totality of knowledge is alone responsible for producing new sort of learning.

Constructivism is a process of learning in which learners become active participants, drawing upon their personal experiences and their interaction with others to construct new understanding and knowledge (Rana, 2010). Constructivists argue that people construct meaning through their interpretive interactions with and experiences in their social environment. It presumes that prior knowledge and experience play a significant role in learning and form the basis for subsequent actions. Fosnot (1989) defines constructivism according to four principles as: i) Learning depends on what individuals already know; ii) New ideas occur as individuals adopt and change their old ideas; iii) Learning involves investing ideas rather than mechanically accumulating a series of facts; iv) Meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas.

Constructivism is best understood in terms of how individuals use information, resources and help from others to build and improve their mental models and their problem solving strategies (Woolfolk, 2007). The constructivist model of teaching enables learners to construct knowledge, whether this construction reflects objective realities, or the construction is perceived to sharpen one's cognitive development for acquiring higher level intellectual development, or the construction of knowledge should happen in a social interactive setting with the meditation of individuals. Two major version of constructivism are; cognitive constructivism believes that people give meaning to their experiences through four stages of cognitive development in which assimilation and accommodation play a crucial role in teaching, and social constructivism believes that individual social interaction and their cultural code play a significant role in the construction of new understanding and knowledge.

At last constructivism is a learning theory in which learning is both an active process and a personal representation of the world. In this theory knowledge is constructed from the experience and is modified through different experiences. Problem solving and understanding are emphasized in this theory.

Social Constructivism. Socio-cultural cognitive theory was propagated by a Russian psychologist, Lev Semyonovich Vygotsky. According to this theory knowledge construction process as a collaborative process, in which it is constructed through the interaction with adults and culture. Through these interactions, children learn the habits of their culture including speech patterns, written language, mathematics, and other symbolic knowledge (Rana, 2010). The key premise of Vygotskian psychology is often referred as cultural mediation.

Social constructivism is based on the social phenomenon. People acquire the knowledge from their social practice through the experience, which they get from the adult activity and their environment. These assumptions allow the social constructivist epistemology to be developed from the two principles of radical constructivism, which are: Knowledge is not passively received but actively built up by the cognizing subject and the function of cognition is adoptive and serves the organization of the experimental world, not the discovery of ontological reality.

The social constructivist focus on actual production of scientific knowledge but not social factors and social practices influences scientific facts and its elements. The most elements in this theory are the assumptions that human being rationalize their experience by creating a model of the social world and the way that it functions and the belief in language as the most essential system through which human construct reality.

Vygotsky (1978) states that cognitive growth occurs first on a social level, and then it can occur within the individual. To make sense of others and construct knowledge on such a social level allows learners to relate themselves to circumstances. Individual's knowledge is found in their interaction with their surroundings and other people before their knowledge internalized. It means that the knowledge is existed in the society. First the children interact with his/her social environment then he/she taught him/herself according to their own environment. Then he/she made own sense about objects. Thus society, which includes environment, languages and other adult practices, is the source of permanent knowledge for a child. In the similar way mathematical knowledge is also acquired from the social and adult practices.

Socio-cultural cognitive theory, asserts three major themes regarding Social interaction, the More Knowledgeable Other (MKO) and the Zone of proximal development (ZPD)."Zone of proximal development"(ZPD) is Vygotsky's term for the range of task that are too difficult for the child to master alone but that can be learned with guidance and assistance of adults or more-skilled children. Vygotskian zone of proximal development is the difference between the child's capacity to solve their problem on his/her own and his/her capacity to solve them with assistance. On the other hand, the ZPD includes all the functions and activities that child or a learner can perform only with the assistance of or someone else. The person in this scaffolding process providing non-instructive intervention could be an adult such as parents, teacher, and caretaker.

In Vygotskian theory, the more knowledgeable other refers to someone who has a better understanding or a higher ability level than the learners, with respect to particular task, process, or concept. The MKO may be a teacher, parent, and an adult

having better knowledge or a peer. The role of MKO is "scaffolding", in which he or she plays the role of a facilitator or a guide. Scaffolding is performed through social interaction in which cultural tools such as culture specific language, codes, symbols, mathematics, and logics play a significant role. Learning of an individual is largely affected by culture where they stand.

In the context of studying the behavior of the students, social constructivism, philosophy of mathematics argues the mathematical practice begun from the society and social activities. It means students have mathematical knowledge. So, the Vygotsky's theory of ZPD was helpful to prepare the theoretical frame to understand the student's mathematical thinking and their behavior in the society and their working field. I borrowed the theoretical ideas from ZPD that human behavior is determined in the form of language, cultural situations, communication, and social factors which influence the human behavior.

Conceptual Framework of the Study

Conceptual framework provides the information about the structure/ content of the whole study based on the literature review and personal experiences. It is the key part of research study. The conceptual framework of this study is given by following figure:

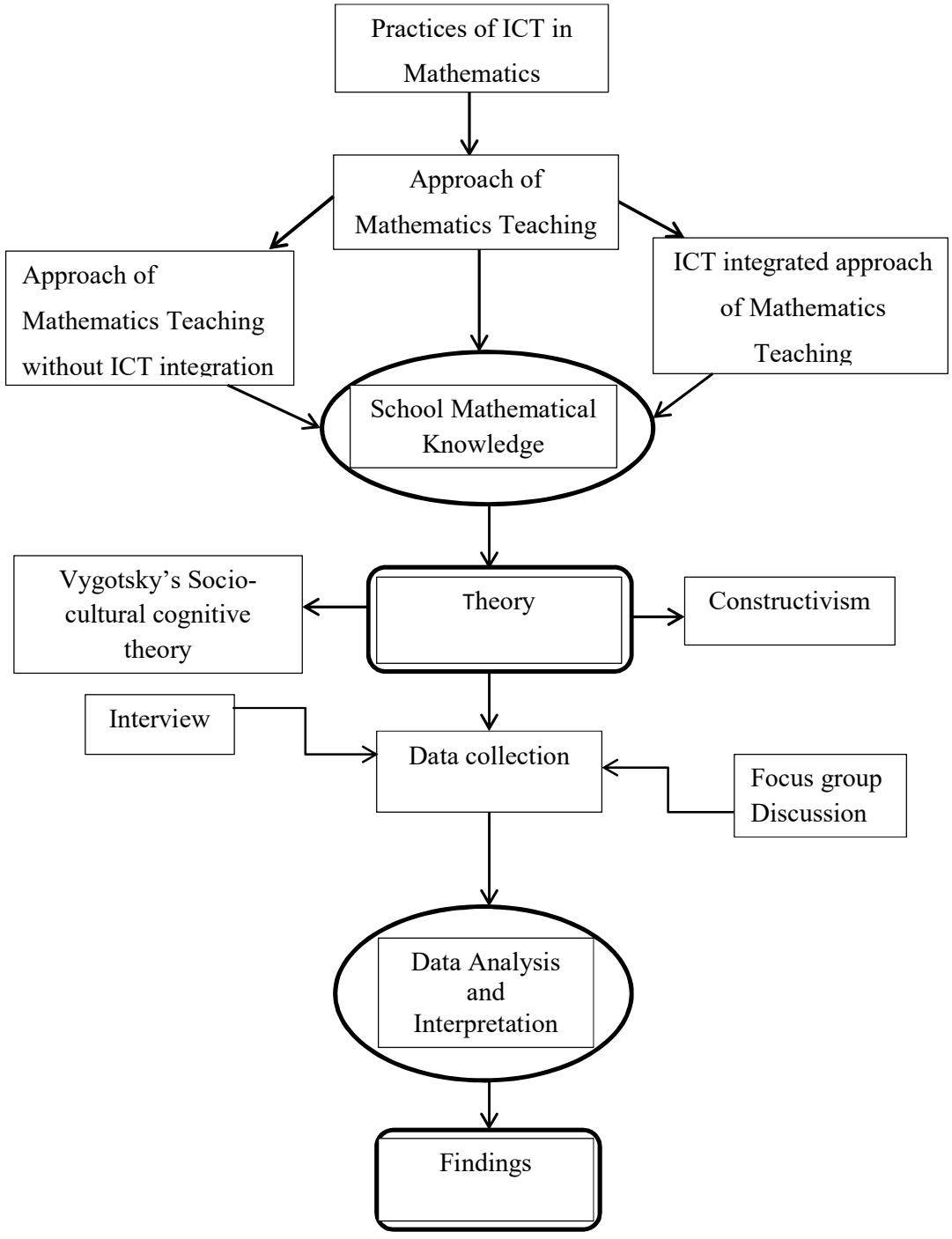

Figure: 2.1. Conceptual Framework

In the above figure use of ICT in Mathematics is the main issue in this study. This framework is linking between traditional approach of Mathematics teaching and ICT enabled approach of Mathematics teaching for school mathematical knowledge. Constructivism and Vygotsky's socio- cultural cognitive theory are the theories for the Theoretical literature review. Interview, focus group discussion and document analysis are the tools of data collection which are linked with above theories. On the basis of collected data, possible findings have been presented.

Chapter - III

Methods and Procedures

This chapter presents the procedure of the study which were carried to achieve the objectives of the study and to get the answer of the statement of the problem. It deals with the research design, population and sample, data collection tools, quality standard of tools, data collection process, data analysis, and interpretation process.

Design of the study

The research design is the detailed plan of the whole study. Educational research can be divided into three broad categories as: Qualitative research, Quantitative research, and mixed research. This study was based on qualitative research design. Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Qualitative research is about person's life, stories and behavior. It is non-quantitative analytical procedure. Qualitative research is based on phenomenological paradigm, which uses a variety of interpretive research methodologies. According to Kumar (2011), the main focus in qualitative research is to understand, explain, explore, discover and clarify situations, feelings, perceptions, attitudes, values, beliefs and experiences of a group of people.

. Qualitative research is especially important in the behavioral sciences where the aim is to discover the underlying motives of human behavior. Through such research we can analyze the various factors which motivate people to behave in a particular manner or which make people like or dislike a particular thing. It may be stated, however, that to apply qualitative research in practice is relatively a difficult job and therefore, while doing such research, one should seek guidance from experimental psychologists (Kothari, 1990).

Case study approach. According to Jack & Hersh (2008) case study research approach is a research methodology that helps in exploration of phenomenon within some particular context through various data sources, and it undertakes the exploration through variety of lenses in order to reveal multiple facets of phenomenon. The major concern of my study was to find out challenges encountered by teachers while applying ICT integrated pedagogy. So, for achieving this major concern the case study approach was adopted under the qualitative research design because according to Creswell (2007) in the case study approach, the data is collected through direct observation in a natural setting and actual incident on the spot. Here, the case is the process of selecting a limited number of students & doing research on those students and collecting data from them. And also, the objectives of this study were to explore present ICT practices in secondary school and to explore the challenges encountered by teachers in ICT integrated pedagogy. I thought only the case study approach fulfill these objectives, so I applied this approach in this study.

Research Site

The research site of this study was Lalitpur district. Two mathematics teachers who used ICT integrated pedagogy from Lalitpur district were selected for interview and FGD was conducted in Magar Gaun Secondary School, Konjyosom-2, Shankhu; Lalitpur. I had a convincing reason for selecting the school it was located in rural part of Lalitpur district & was familiar to me. For collecting data easily, Lalitpur district was familiar to me so I chose it.

Selection of Respondents

This is qualitative research. So the sample size in this study is small. The sample size of the research depends on the purpose research and credibility of the study. I selected two mathematics teachers who were being teaching in ICT enabled

classroom and eight students from a school who were engaged in ICT enabled classroom were consider as the respondents who had addressed the researcher's study. On the basis of research objectives, I selected respondents and participants purposively.

Data Collection Tools

Qualitative research was carried out with a qualitative approach to understand the exploratory reasons and to assay how and why a specific phenomenon operates. Tools are very important factor in each study for data collection. Qualitative research involves several methods of data collections such as focus groups field observation, in-depth interviews, and case studies (Roger and Joseph, 2015). The researcher had worked closely with respondents in a natural setting as much as possible in order to collect essential data. So, I had collected data from following tools and techniques. The following tools were used for data collection in this study.

Interview. Interview is the common tool of data collection. Interview is the process of collecting information from person. The interview is conversation with a purpose. The main purpose of interview is to find out what is in and on someone else minds (Merriam, 1988). Interview helps us to find out what we can't be directly observed, for example feelings, thoughts and intentions. Instead of writing the response, the subject or interviewee gives the needed information orally in to face-to-face manner. Interview helps to get information which they are not obtained from observation. The advantage of interviewing is that the interviewee can explain more explicitly the investigation purpose and just what information he/she wants. If the subject misinterprets the questions, the interviewer may follow it with a clarifying question. At the same time, he/she may evaluate the sincerity and insight of the interviewee.

Interview was grabbed with two mathematics teachers who used ICT integrated pedagogy in mathematics teaching. With the help of interview schedule, I had tried to dig out the challenges encountered by those teachers who were applying ICT integrated pedagogy in mathematics teaching. On the basis of objectives, I had developed interview guideline consulting with supervisor in semi-structured form which had been kept in appendix (See Appendix A).

Focus group discussion. A focus group discussion (FGD) is gathering of people from similar background or experiences together to discuss a specific topic of interest. The crucial element of FGD is the facilitation. Some important points to be noted in mind in facilitating FGD are to ensure even participation, careful wording of the key questions, maintaining a neutral attitude and appearance, and summarizing the session to reflect the opinions evenly and fairly.

. The eight students of Shree Magar Gaun Secondary School of Lalitpur district were the participant's for the focus group discussion. After building a good rapport, discussion was started with some questions. I had conducted the FGD to dig out the participant's view toward ICT integrated mathematics teaching. I had developed FGD guideline with consulting supervisor to achieve the objectives of study which had been kept in appendix (See Appendix B).

Data Collection Procedure

For this study, I had visited to the selected school and took consent from the school stakeholders and build up a good rapport with the informants. Then, I had conducted an interview with the teachers. I used interview guidelines in interview. For the unclear concepts, I provided some explanation where they need. I had used some questions which were not included in interview guidelines, but necessary in such situation.

I had gone Shree Magar Gaun secondary school and I met principal of school. I told all about my study, and gave my research proposal. He informed for all teachers about my study. After that, the principal agreed to give permission for me to conduct FGD. Then, I organize the FGD guideline. After a week, I again gone to school and gathered selected students. I convinced them and made ready for FGD on my topic and used some open ended questions based on FGD guidelines. I made some explanations where they need and probe them to put their view independently. I had used the dairy and cell phone for voice recorder to put notes to collect data. I listed the responses of respondents curiously and noted them in paragraphs.

Data Analysis Procedures

According to Thomas (2006), following strategies and principles are underlying in the general inductive approach: i) Data analysis is guided by the evaluation objectives, which identify domains and topic to be investigated, ii) the primary mode of analysis is the development of the categories from the raw data into model or framework, iii) the finding result from multiple interpretations made from the raw data by the evaluator who code the data, iv) different evaluators may produce finding that are not identical and that have non overlapping components, and v) the trustworthiness of findings derived from inductive analysis can be assessed using quality standard.

To analyze the verbal data of FGD and interview, I followed the general inductive approach for qualitative evaluation data. First of all, I have organized the collected information from interviews and FGD. Then identify the domains and topics to investigate on the basis of objectives. For coding the verbal data of interview and field notes, I prepared raw data files, read and re-read the text in detail until the completely apprehend the text, create and define the categories related to research objectives,

reduce overlap and redundancy among categories and create a model of incorporating most important categories. Then, I generated the different code according to responses of participants. At last, I have analyzed and interpreted these codes by using the constructivism theory and conceptual framework which I have developed in literature review.

Quality Standard

After completion of the construction of the research tools, it was necessary to maintain quality standard. The developed tools for qualitative data were validated by consulting with the supervisor. Then the valuable suggestions from above personnel have been included and the tools of data collection were modified accordingly. For quality standard, I followed the following ways;

Credibility. This concepts replaces the idea of internal validity, by which researcher seeks to establish confidence in the truth of their finding. For the accuracy of the study, I had spent approximately 2hours for interview with each teacher as well as 3 hours for FGD. I had written notes. Also for the accuracy of the research, I analyzed data carefully.

Transferability. Transferability replaces the concept of external validity. This criterion refers to the applicability of finding is one context (where the research is done) to other contexts or setting (where the interpretations might be transferred). To maintain transferability, I took photos while conducted interview and FGD and also photos of ICT lab of selected school. I also took voice record of interview and FGD. And also, to maintain transferability, I had tried to capture most of the scenario by using the thick description of interview, FGD, and my meaning making.

Conformability. Conformability refers to the quality of the results produced by an inquiry in terms of how well they are supported by informants who are involved

in the study and by events that are independent of the inquiry (Khanal, 2019). It also referred as audit trail (a record of how decisions were made throughout the study) which allows any observer to trace the course of the research step by step via the decisions made and procedures described. For maintaining conformability before concluding information I have reviewed that information myself several times.

Research Ethics

Any kinds of harming action were not done to anyone with whom I came into contact. Interview and FGD were conducted only after giving all the prior information to the participants about the study and with consent of students & their parents, teachers and head teachers of selected school. Furthermore, I explained verbally that the information provided by them were confidential. I assured them that anonymity was maintained. I sincerely tried to avoid plagiarism and biases in the presentation of respondents' information. Also, I assured that the findings of this study were not submitted for any other purpose.

Chapter – IV

Data Analysis and Interpretation

The main body of the research is analysis and interpretation of the data. It provides the layout of the findings as well as the analysis of the findings in accordance with the research objectives and the research question of the study. So, this chapter helps to achieve the objectives of the study on the basis of method and procedures. This chapter presents the analysis and interpretation of the data which the researcher collected from the different documents related to ICT in education, two different mathematics teachers and seven students of a school of Lalitpur district. In order to analyze the collected data from interview schedule and focus group discussion, the researcher had used qualitative technique.

This chapter provides the layout of the findings as well as the analysis of findings in accordance with the three research objectives and the three research questions of the study. This chapter is divided into two themes: practices of ICT in mathematics teaching and challenges encountered by teachers in ICT integrated pedagogy and measure to cope challenges for promoting ICT integrated pedagogy in school.

ICT Related Practices in Schools

In context of Nepal, ICT integrated pedagogy was new trend. After implementation of Information and Communication Technology in Education Master Plan (2013-17) access to the computers and internet in schools was grown which allow for the scaling-up the use of ICT in school education. Different programs after ICTMP were executed to scaling-up the use of ICT in education through Department of Education and other some NGOs and INGOs. Matching fund programs under DOE, One Laptop per Child (OLPC) program, Open Learning Exchange (OLE)

Nepal's E-Path and E- Pustakalaya platform, Midas e-class were some executed programs which help to scaling-up the use of ICT in education.

Different policies like School Sector Reform Program (SSRP) (2009-2015), School Sector Development Plan (SSDP) (2016-2023), ICTMP (2013-2017), and other policy suggested to using ICT in education for effective learning. But in practice level, only few number of public and community schools practiced ICT integrated pedagogy.

Minimum use of ICT tools in mathematics classroom. Different ICT tools can be used in mathematics teaching in terms of software based, multimedia based and internet based tools. OLE Nepal initiated an online portal E-Path and E-Pustakalaya to provide access to educational resources to students, teachers and parents. Some internet based ICT tools like www.midas.com.np, www.khullabs.com, www.khullakitab.com, dlc.dwit.edu.np, sikai chautari; Nepal government's online learning platform under the domain learning.cehrd.edu.np and other online portal should be used in mathematics classroom. Different software like Geogebra, Wolform Mathematica, Microsoft mathematics, and Photomath might be used in mathematics classroom. NCED virtual class, documentaries, audio document broadcast by radio and YouTube channels related to mathematics might be used in terms of multimedia based ICT tools.

By using different ICT tools, we can make mathematics class effective which helps learner for effective learning. Different research suggested for using ICT in mathematics teaching for effective learning. School Sector Development Plan (SSDP) (2016-23) aims to use ICT as a significant tool to improve classroom delivery, maximize access to teaching learning materials and enhance the effectiveness and

efficiency of educational governance and management. But the question is how far we are implementing ICT for teaching and learning.

In this regard, one of my student participants B, shares his view as

"*I heard Geogebra software when I was in grade nine. My teacher used Geogebra for teaching set, geometry, and mensuration. In addition my teacher used Smart Notebook for construction. Sometimes he used projectors and power points in classroom. He suggests us to watch NCED virtual class as well as to visit dlc.dwit.edu.np and different youtube channels related to mathematics."* (FGD, Participant B, Student)

Similarly, teacher participants B shares

"In our school there were 10 computers and 2 projectors whereas students were 30 - 35 in each class of secondary level. One projector was fixed at ICT lab. I use different ICT tools in teaching process like computer, projector, MS PowerPoint. Similarly, I use different mathematical software like GeoGebra, Mathpad, and Smart Notebook. I use different YouTube channels related to mathematics. When I convey projector at classroom, it took more time to setup. Internet facility was available in school. But sometime while I teach through ICT, internet did not work properly which made class disturb." (Interview, Participant B, Teacher)

From the above information, I found that teacher used ICT tools in mathematics classroom. He used different ICT tools like projector, power points, Geogebra and Smart Notebook software for teaching set, geometry, mensuration and construction. He suggested students for media based and internet based tools but not used in classroom. Similarly, he did not use mobile apps for mathematics teaching. Also ICT tools were not used for all chapters.

In this line Higgins (2003) considered ICT as a powerful tool to visualize complex concepts and make them lively, to manipulate and deliver information through texts, pictures or graphs, but not to teach skills. He claimed that innovative use of ICT in instructional activities can transform traditional pedagogy and direct the teachers as well as learners to constructive thinking and innovative activities.

Likewise, Joshi and Rawal (2021) indicated that khullakitab.com and midaseclass.com have some uses than others online resources which may cause that these resources have been developed on school curriculum of Nepal besides this the teachers have poor knowledge of online resources (Joshi & Rawal, 2021). In addition, many mathematics teachers in Nepal have general knowledge of technology but practice level in classroom is not satisfactory. Some of them used few numbers of ICT tools in their classroom in available limited sources of ICT.

Inadequacy of ICT infrastructure. ICT infrastructure is not only a set of equipment or elements. ICT infrastructure refers to the availability of equipment, software, internet access and other similar resources in the school (Pelgrum, 2001). It is one of the basic pillars of ICT in education. ICT infrastructure includes ICT equipment, internet connectivity, multimedia classroom and educational resource sharing platform. Without proper ICT infrastructure someone could not teach mathematics through ICT integrated pedagogy.

In this regard, one of my teacher participants A, shares his view as

"*In our school, there are 27 computers, two projector and some other devices of ICT. Projectors were not installed in each class. There are 50-55 students in classroom. If I want to teach through power-point or ICT either I take away laptop and projector to classroom or I transport students from their classroom to ICT lab.*

Internet connection was available in our school. But alternative source of electricity was not available in our school." (Interview, Participant A, Teacher)

Similarly, student participant D, shares her view as

"*In our school there are 27 computers, two projectors and other devices of ICT are available. One projector is fixed in ICT lab and other is not. Our teacher usually used ICT tools in teaching and learning. Sometimes our teacher transports us to ICT lab and sometimes he takes away projector and laptop in classroom. Due to poor connection of internet he was unable to show NCED virtual class. Sometime electricity also disturbed the running class."* (FGD, Participant D, Student)

From above mentioned views, it is noticed that ICT infrastructure is inadequate in school. 27 computers, two projectors and other devices are available in school whereas each class of secondary level has 50-55 students. This showed those available ICT infrastructures are inadequate in reference of students. There was a condition that either teacher takes projector in classroom or transport students in ICT lab while teaching through ICT. Also, there was available internet connection and electricity facility.

In this regard, economic survey (2019/20) stated that out of 29,607 public schools across the country, computer facilities have been made available in 8,366 schools. Among 8,366 schools 3,676 schools have been using information technologies in teaching and learning activities (MOF, 2020). Currently 13% of schools have facilities to access the internet (Flash I, 2019/20), and 55% house of households have access to the internet in their households and 51% of students could access media such as radio and TV (CBS, 2020). This shows about 71.74% public schools have not computer facilities and 87% schools have not internet facilities.

Thus, governments' programs are not sufficient for ICT in education but gradually increase in recent years.

After the implementation of the Information and Communication Technology in Education Master Plan (2013-2017), access to computers and internet in schools which allow for the scaling-up the use of ICT in school education. Currently out of 29607 schools about 28% schools have computer facilities. This shows that government program for supporting ICT in education is not sufficient but gradually developed in recent years.

Lack of technical supports. A mechanism to provide technical assistance for ICT infrastructure, quality of equipment and its protection and maintenance is important in ICT integrated pedagogy. Resta (2002) defines technical support as specialized skill personnel who are able to support and assist the educators in implementing technology in instruction. It is obvious that technical support is important to teachers. Technical support has an encouraging impact on teachers own use of ICT, and their integration of ICT into the teaching learning process as well.

In this regard, teacher participants B, shares his view as:

"Our school has not computer teacher who can provide technical support related to ICT. When I got hardware problem on computer, I cannot solve that problem which disturbs in teaching process. Likewise, different trainings are required to support for integrating ICT tools with curriculum but there is less opportunities of that types of training."

From above mentioned view, I noticed that schools have very little number of capable human resources for supporting ICT integrated pedagogy. Similarly, training conducted by government related to integrate ICT with curriculum was not gained by

teachers proportionally. And also, teachers have fundamental concept of computer but not have more knowledge about hardware.

In this regard, Joshi & et.al (2021) indicated that ICT competency of mathematics teachers of secondary and lower secondary schools in Nepal has been found to be in proficiency level in relation to the fundamental concept of computers and the use of the Internet, whereas it is at developing level in case of the use of software and hardware.

The lack of technical supports creates difficulties and result in diminished support for the curriculum. Technical support is required to teachers who applying ICT integrated pedagogy to use ICT tools effectively in their teaching activities. Thus, technical supports should be well prepared for the teachers in order for them to successfully integrate ICT with curriculum. Teacher training providers should emphasize their activities in developing software and hardware skills related to content and pedagogy.

Views of Students on ICT integrated pedagogy

ICT integrated pedagogy is the approach that integrates ICT alongside the curriculum which changes the role of teachers and increases student's control of their learning, self-regulation and collaboration. This presupposes a shift from traditional lesson formats, based on transmitting information philosophies, towards student-centered approaches that promote active engagement, help them to control their learning and collaborative learning and meaningful understanding. One of the purposes to introduce ICT in education is support effective learning. Use of ICT integrated pedagogy can transform the dynamics in math classes, making the lectures integrated practice and providing resources that help in securing content and approach

of theory with everyday life (Bhattarai, 2019). It is important, therefore, to examine the student's views on ICT integrated pedagogy.

. Furthermore, the researcher has asked the students that: *Do you discuss with your friends about mathematical problems?* The students answered:

"*I tick the problems that I cannot solve at home and ask them with friends as well as teachers. I gained many ideas through discussing with friends as well as teacher."*

"I get help of my brother if I get problem in solving mathematical problems at home. Also I ask with friends and teacher for the problems at school."

"There is nobody to guide me in my study at home. So, if I got confusion about problem, I used to watch related videos on YouTube. Also I shared the problems with friends as well as teacher and get many ideas about problems."

According to Vygotsky (1978), much important learning by the child occurs through social interaction with a skillful tutor. The tutor may model behaviors or provide verbal instructions for the child. Vygotsky refers to this as cooperative or collaborative dialogue. The child seeks to understand the actions or instructions provided by the tutor then internalize the information, using it to guide or regulate their own performance. This tutor is also categorized as More Knowledgeable Other (MKO).

The MKO is somewhat self-explanatory; it refers to someone who has a better understanding and considerable higher or superior level of ability, skill or knowledge about a particular subject, task or process than learner. The MKO often comes in the form of teacher, a superior at work or a peer with more experience. In fact, the MKO need not person at all. In this digital age, the MKO may even be a computer or any

intelligent machine. Electronic tutor has also been used in educational settings to facilitate and guide students through the learning process.

The above mentioned views of students were stated them by separately. One of them learned through interaction with his/her friends and teachers. Another learned by the guidance from other at home and with friends and teachers. She/he feels easy in learning through interaction with friends and teachers. Another used to watch videos in YouTube for learning. Moreover, learning through interaction with others helps to make learning effective and sustainable. The above presented students answer shows that teacher as well as their peers who have better knowledge than them and YouTube are MKO for the learners.

Vygotsky stated that students must be encouraged to search for new knowledge and formation of concepts themselves. From above mentioned answer of students, I found that most of the students were actively participated in learning mathematics through different means like asking to the seniors at home, taking part in the discussion with friends by encouraging them in solving problems, watched problem related videos in YouTube. If the solution hadn't got from the interaction, they had to ask teacher for the solution. These activities are matched with the social constructivism proposed by Vygotsky.

Visualization of concepts. Visualization strategies facilitate the goal of achieving students' engagement in the classroom. This strategy gives opportunity for students to see and examine something. Visuals help students make the transition from abstract mathematical concepts to concrete. The researcher asked to the students that: *Have you heard about Geogebra software? How do you feel about using Geogebra?*

In this regard, student participant A, shares his view as:

"I heard about Geogebra software when I was in grade nine. My teacher used Geogebra for teaching parallelogram, construction, circle and similarity in class nine. Also my teacher used Geogebra for teaching triangle and parallelogram, circle, mensuration in grade ten. For construction, my teacher used Smart Notebook in grade ten. I feel that Geogebra is better for making clear concept about 3D figures like cylinder, cone, sphere and hemisphere, prism and pyramid." (FGD, Participant A, Student)

Similarly, other student participant C, shares her view as:

"I heard about Geogebra at grade nine. While my teacher teaches about experimental verification of circle, I feel uneasy to understand it. After visualization through Geogebra, I understood in better way that the circle's part, relation of central angle and inscribed angle and cyclic quadrilateral."(FGD, Participant C, Student)

Likewise, student participant F shared his view as:

"Geogebra supported me to understand very well about mensuration especially combined figure. For e.g. the volume of combined figure (cylinder + hemisphere) can be calculated by volume of cylinder + volume of hemisphere but the total surface area of same figure cannot be calculated by T.S.A of cylinder + T.S.A of hemisphere. I got confusion that why T.S.A of cylinder + T.S.A of hemisphere cannot be used for calculating T.S.A of combined figure (cylinder + hemisphere). When teacher visualized through Geogebra, I saw that plane surface of hemisphere is overlapped with one plane surface of cylinder. As a result, curved surface of hemisphere, curved surface of cylinder and one plane surface of cylinder is the total

surface of combined figure. So for T.S.A of same figure, we use T.S.A of hemisphere + C.S.A of cylinder. I feel very happy teaching mensuration part through Geogebra." (FGD, Participant F, Student)

In this way, among eight students who participated in FGD, all of them heard about Geogebra software at grade nine. They said that their teacher used Geogebra software for teaching construction, mensuration and geometry (Triangle and parallelogram and circle). Also all of them said that, Geogebra software supported them for their study.

The concept of MKO is integrally related to the Zone of Proximal Development (ZPD). The ZPD is the distance between what a person can do with and without help. ZPD defined as the difference between actual level of development as determined by independent problem solving and the higher level of potential development as determined through problem solving under guidance or in collaboration with more capable peers (Vygotsky, 1978). Vygotsky stated that learners should be taught in the ZPD where learners construct new knowledge through social interaction. Here the higher ability students play a role in helping the lower ability students to reach their ZPD. Also higher ability students are benefited through interaction with peers for making new ideas and views. The above mentioned views of students, Geogebra supported them for learning mensuration, construction as well as geometry. Here Geogebra software plays a role of MKO which always encourages students to learn and reach their ZPD. Also, I found that teacher, higher ability peers, Geogebra software encouraged students to learn and guide to reach their ZPD of Vygotsky's social constructivism.

The researcher, to know about students' view on ICT integrated pedagogy, asked question as *Did you get any difference with use of ICT and without use of ICT while learning mathematics?*

In this regard, student participant B, shares his view as:

"There is vast difference between learning mathematics with and without use of ICT. While teacher explored about 3D figures without using ICT, I feel very hard to understand. But when my teacher visualized 3D pictures with ICT tools, it helped me to made clear concept about 3D figures." (FGD, Participant B, Student)

Similarly, other student participant C, shares his view as:

"While teacher teaching without using ICT, it takes long time to explain the content. But when teacher used ICT in teaching, we were able to comprehend about content in short period." (FGD, Participant C, Student)

The above mentioned views of students showed that there is vast difference between studying by using ICT and without using ICT. The students were able to comprehend easily and in short time while using ICT in mathematics learning. They are actively participated in interaction process as well as they gave interest for problem solving related to topic by self-study. These activities were matched with social constructivism of Vygotsky. ICT integrated pedagogy encouraged students to learn actively.

Social constructivists stated that learning is active process where learners should learn to discover principles, concepts and facts for themselves; hence they encourage and promote the guesswork and intuitive thinking for learners. Furthermore, the researcher had asked students that: *Do you think, is the use of ICT effective while learning mathematics? If yes, how it is effective? What changed?*

In this regard, one of my student participants A, shares his view as:

"I felt that use of ICT in mathematics teaching is effective. For e.g. Teaching with ICT allow us step by step formula derivation process of mensuration with visualization. Thus teaching with use of ICT encourages us for meaningful learning rather than rote learning." (FGD, Participant A, Student)

Similarly, other student participant D, shares his view as

"After studying through ICT, I was able to made model of cylinder, cone, triangular prism, square base pyramid by using papers. I can distinguish between circle and sphere. ICT enabled teaching helped to perceive clear concept for 3D figures rather than in lecture method." (FGD, Participant D, Student)

In the similarly way, other student participant H, shares his view as

"I was able to relate geometrical concepts to the objects our surrounding through ICT enabled instruction. For e.g. White board can be compared to rectangle. Football is in sphere like shape as well as lemon, table tennis ball are similar to sphere shape. I found my house was similar with combined figure (rectangular prism + triangular prism). So, use of ICT in teaching mathematics is very effective for me." (FGD, Participant H, Student)

The above mentioned views of students show that the use of ICT in learning mathematics was very effective. They were able to comprehend clearly about 3D figures rather than in traditional teaching method. They were also able to relate geometrical concepts with their surroundings. ICT integrated pedagogy brought creativity in students. As a result they were made different model of geometrical objects. It also encourages students for intuitive thinking. Students are curious to search combined figures in their surroundings. The research shows that the students

can be engaged in interaction and self- exploration by using ICT in teaching process which helps to reach ZPD of Vygotsky's social constructivism. I found that students have positive attitudes towards ICT integrated pedagogy because students actively participated in learning process than in traditional teaching method.

Challenges Encountered by Teachers in ICT integrated pedagogy

ICT has utilized in the field of teaching and learning process in Nepal from few years. The common barriers for ICT integration in institutions are lack of infrastructure, digital learning resources and continuous professional teacher training in computers (Varughese, 2011), lack of ICT integration related training opportunities, lack of sufficient time management in schools, lack of technical supports, poorly update with new technology.

Different policies of Nepal related to ICT are available in the field of education. The aims of these policies are better for improvement even financial investigation in the field of ICT in education. In practice level private schools are trying to integrate it in their pedagogical practices even public schools have poor exercises. It is important, therefore, to examine the challenges faced by teachers in ICT integrated pedagogy. In this research, the researcher collected qualitative data to fulfill the objectives. To find out the challenges encountered by teachers in ICT integrated pedagogy, the researcher conducted interview with two mathematics teachers of Lalitpur district who used ICT integrated pedagogy. The interview guideline for teacher has been included in appendix-B. Furthermore, the researcher has questioned that: *In teaching process, which ICT tools are you used?* The responses of teachers are presented below:

Teacher-A

"In teaching process, I frequently use ICT tools. I use computer, projector, power point, Geogebra software for geometry and mensuration, Mathpad and Smart Notebook for construction. Similarly I use NCED Virtual Class for different chapters." (Interview, Participant A, Teacher)

Teacher -B

"I use different ICT tools in teaching process like computer, projector, MS PowerPoint. Moreover, I use different mathematical software like Geogebra, Mathpad, and Smart Notebook. I use different YouTube channels related to mathematics. Sometime I also use Smart Board for teaching." (Interview, Participant B, Techer)

The above mentioned responses of teachers show that they were aware about use of ICT in mathematics teaching. They used different ICT tools for teaching. Computers, projector, power point slides different mathematical software like Geogebra, Mathpad, Smart Notebook and different YouTube channels are used by teachers in teaching learning process for effective learning. Furthermore, the researcher asked that: *In your opinion, what are the benefits of using ICT in mathematics teaching?* Teacher-A responds that:

"I found many benefits of using ICT in mathematics teaching. Firstly, it is supportive to deliver mathematical concepts in effective way. Students are actively participated in mathematics classroom. It helps students to link geometrical concepts to their surroundings. It helps to motivate students. It helps to visualization of mathematical contents."

Similarly teacher –B responds that:

"Use of ICT in mathematics teaching has many advantages. It helps to visualize the abstract concept of mathematics which made easy to perceive about different geometrical concepts. Students understood formula derivation process of three dimensional figure as well as combined figures easily than in traditional method of teaching. I found that students are more motivated when I use ICT in teaching. They are curious for learning."

The above mentioned answer of teacher shows that use of ICT in mathematics teaching has many benefits. Use of ICT allows opportunity to visualize mathematical content which made easy to perceive mathematical content for students and to deliver mathematics concepts in effective way for teachers. Students are actively participated in mathematics classroom in ICT integrated pedagogy. Students are curious to learning and they are more motivated towards learning while ICT is used in mathematics teaching. They learned in collaboration and cooperation with their friends and teachers. This matched with Vygotsky's social constructivism.

ICT integrated pedagogy is adopted in teaching since this decade in Nepal. It faced with many challenges. So far, ICTs have not been used as a way of acquiring new knowledge and skills due to inadequacy curriculum content, limited access to ICTs, inadequate funding and lack of basic infrastructure. The challenges encountered by teachers in ICT integrated pedagogy were presented as follows:

Learning management. Learning management is the process by which teacher and schools create and maintain appropriate behavior of students in classroom settings. It helps to increase student's success by creating an orderly learning environment that enhances student's academic skills and competencies as well as their social and emotional development. The researcher asked that: *what types of*

challenges related to classroom management have you faced while teaching through ICT?

Teacher –A shared his view as:

"Students are actively participated in classroom while I teach through ICT. But there is not available of projector in each class. Students took more time to enter in ICT lab from their classroom which obstructs to deliver the content that I intended. Some students feel uneasy while teaching through ICT due to their vision problem."

Teacher –B shared his view as:

"*In our school two projectors were available. Among them one was fixed in ICT lab and another is not fixed. When I teach in ICT lab, students took more time to enter in ICT lab from their class. If I use another projector in classroom it takes some time to setup. These both hamper me to deliver intended content. There are 50-55 students in classroom. When I provide time to discuss, some students makes noise. If electricity was gone at teaching time they made loud noise which disturbs the class."*

The above mentioned responses of teachers indicate that there were some challenges in class management while teaching through ICT. Both schools have not enough projectors. Students took more time to enter ICT lab from their classroom. It made difficult to time manage of a period. So, teacher could not able to deliver the content that she/ he intended.

Similarly, one of my student participants G, shares his view as: *"I have eye problem. When teacher used ICT in teaching, it helped us to perceive knowledge but due to my problem I feel uneasy. Thus, I went to last bench."*

This statement implies that the persons who have vision disabilities get problems in ICT integrated pedagogy. Thus, the teacher should know about their

students and give priority for those students who have vision problems for classroom management.

Electricity. Electricity was essential for ICT integrated pedagogy. Without availability of electricity we could not think about ICT integrated pedagogy. The researcher asked for respondent that: *Is electricity facility and its alternative available in your school?*

Teacher –A replied that:

"Electricity was available in our school. Due to geographical intricacy, if electricity was gone, it takes more time to recover it. The alternative source of electricity was not available in our school. If electricity was gone, I was unable to teach through ICT."

Teacher –B replied that:

"Electricity facility as well as solar system was available in our school. If electricity was gone, it takes some time to operate solar system which made class disturb for some time."

The above mentioned responses indicated that both schools have electricity facility. One school has also solar system. But if electricity was gone, it takes more time to recover due to geographical intricacy. So, teacher could not able to use ICT in teaching. Thus there were challenges to practice ICT integrated pedagogy due to lack of electricity facilities.

Time management. Time management was also essential aspect for ICT integrated pedagogy. In ICT integrated pedagogy, different files like power point files, Geogebra files should be made for teaching. To prepare these files it takes too much time. Thus, time management was important task in ICT integrated pedagogy.

The researcher asked to respondent that: *Have you got time to prepare different files in school?*

Teacher –A replied that:

"In school, there was no enough time to prepare different files in school. In traditional method, I prepare about lesson in short time but to prepare files for ICT it consume much time. I made files for teaching at home."

Teacher –B replied that:

"I prepared different files for ICT integrated pedagogy at home. In school, I have six periods among seven periods. So, I have not enough time to prepare files in school. Some time I felt burden to prepare files at home."

The above mentioned views of teacher showed that they have no enough time to prepare files related to lessons due to their periods in school. They prepared files at their home. Sometimes they felt burden in ICT integrated pedagogy.

Financial challenges. Financial aspect was also important for ICT integrated pedagogy. Without proper financial support, ICT integrated pedagogy was not effective. The researcher asked respondent that: *What are the financial challenges in ICT integrated pedagogy?*

Teacher –A replied that:

"School administration directs to use ICT integrated pedagogy in teaching. When I said to bought some software for teaching, the administration did not support for that. If any ICT tools got damage, administration took long time to buy those tools."

Teacher –B answered that:

"Our school has not enough ICT infrastructure but school management committee; school administration did not give concern for this. School has bought ICT tools in time when they got damaged."

The above mentioned answer shows that the teachers have not got financial support for ICT integrated pedagogy from school administration and school management committee (SMC). School administration as well as SMC gave less concern for improving infrastructure of ICT in school. Furthermore, government also provides less financial support for developing ICT infrastructure in schools.

Measure to Cope Challenges for Promoting ICT integrated pedagogy in Schools

This section deals to achieve objectives to cope of the challenges for promoting ICT integrated pedagogy in school. ICT is current issue in the field of education which makes teaching more meaningful, creative, attractive and funny and encourage of learners for self-learning (Joshi, 2017). The participants of FGD highly agreed that the use of ICT in mathematics is a very good approach for learning mathematics, understand mathematical concepts, increase their confidence in solving problems, make them creative, make learning enjoyable and visualize mathematical content.

The development of ICT in education faced with many challenges in our context. The major challenge in our context is lack of physical infrastructure for implementing ICT. Similarly lack of competent human resources on computer class operation, its repairs and maintenance, poor internet services, poor power backup, less attention from SMC on ICT classes are other challenges for ICT integrated pedagogy. But we have to promote ICT integrated pedagogy in school for effective learning.

Furthermore, the researcher asked respondents that: *What measures should be used to cope challenges for promoting ICT integrated pedagogy in school?*

Teacher –A replied that:

"Firstly government should be funding for improvement of ICT infrastructure. If we have well physical lab then we were able to reduce challenges related to classroom management. Similarly government should be providing ICT related trainings which help us to integrate ICT with curriculum and to update with new technology. Different awareness programs related to ICT in education need to be done for aware students and parents."

Similarly Teacher –B replied that

"In my opinion, for ICT integrated pedagogy we firstly improve ICT infrastructure in school. School should made vision to manage ICT labs and ICT integrated pedagogy. Government should appoint competent human resources on computer class operation, its repair and maintenance. There should be ICT related training opportunity to update with new technology. SMC and other stakeholder should be given their attention for ICT integrated pedagogy. School should provide fast speed internet connection and power backup system. Similarly if school provides time to prepare file for ICT integrated pedagogy then I able to reduce burden of preparing files at home which help me to prepare for lesson."

The above mentioned responses of teachers indicated that firstly government should be funding to improve ICT infrastructures in school. Government made policies for ICT integrated pedagogy but not effective in practice level. Many public schools have not ICT facilities till now. There were not enough ICT infrastructure and well labs in schools that have ICT facilities. Government should appoint competent

human resources on computer class operation, its repair and maintenance. Also a teacher who has ICT knowledge need to help other teacher to aware about ICT integrated pedagogy. Similarly local government should be made provision for funding ICT integrated pedagogy as well as teacher training to integrate ICT with curriculum. The ideas of ICT integration with curriculum and different software for different chapters as well as reference materials should be included in teachers' guide which also helps teacher to use ICT in teaching. School administration as well as SMC should encourage and support to those teachers who use ICT integrated pedagogy. Similarly, school should manage time to prepare presentation files for ICT enabled teaching. School should invest for buying different software. School should manage power backup system and internet connectivity with high speed.

Chapter – V

Findings, Conclusion and Implications

This study was concerned to the study on the use of ICT in mathematics teaching. The main objectives of this study were to explore the practices of ICT in secondary school and also to explore the challenges encountered by teachers in ICT integrated pedagogy. Another purpose was to cope of the challenges for promoting ICT integrated pedagogy in school. The purpose of this chapter was to present overall summary of the study. The findings of the study are summarized, conclusion is drawn, and some implications have been made.

In our formal education system, mathematics is core subject in school level curriculum. According to SEE result Summary (Subject wise) (2075), almost half portion of the students who appeared in examination have secured grade below C. This indicates that most of the students have negative impression towards mathematics as an abstract subject. The advancement in the field of technology brought changes in various areas of lives. The development of ICT tools and advancement in technology also influence the education system. The use of ICT tools in education system can enhance meaningful learning better than traditional instructions. Therefore, to encounter negative impression towards mathematics and for effective learning, mathematics teacher should implement ICT integrated pedagogy.

Findings of the Study

The main objectives of this study were to explore the present ICT practices in secondary school and also, to explore the challenges faced by teachers in ICT

integrated pedagogy. The approach of this study was a case study under the qualitative research design. Interview and Focus Group Discussion (FGD) were used as techniques of data collection. The respondents of the study were two mathematics teacher and eight students from grade 10. The major findings of this study were following:

- This study found that, mathematical software like Geogebra, Smart Notebook are used in teaching mensuration and geometry part of grade 10. Other online resources, internet based and multimedia based ICT tools are poorly used in teaching mathematics.
- It is found that, the schools have inadequate ICT infrastructure with reference to their secondary level students. The positive aspect was teachers applying ICT integrated pedagogy in limited ICT infrastructure of school.
- It is found that, different policies of Nepal related to ICT are available in the field of education. These policies focus on ICT integrated pedagogy but practice level in classroom is poor. The various technical supports required to teachers using ICT integrated pedagogy have been found to be scarce.
- It is found that, inadequate presence of ICT infrastructure and ICT tools and some physical disabilities like vision problems of eyes create challenges in learning management.
- It is found that, schools have facility of electricity but schools haven't alternative sources for electricity. Due geographical intricacy, it takes long time to maintain electricity supply system, which disturbed in ICT integrated pedagogy.
- It is found that, schools have internet facility. Poor internet connection also challenged in ICT integrated pedagogy.

- It is found that, fewer opportunities of trainings related to ICT integrated pedagogy hinder teacher to update with new technology.
- It is found that, in mathematics curriculum, how and what types of ICT tools as well as software's could be used in teaching was not mentioned. This is also confusing mathematics teacher for applying ICT integrated pedagogy.
- Teachers have not enough time to prepare different files for lessons due to their class periods in school which made teacher to felt burden in ICT integrated pedagogy.
- It is found that, school management committee (SMC) as well as school administration gave less concern for improving ICT infrastructure.
- It is found that ICT enable pedagogy supports students for conceptual learning. Also students have positive attitude towards ICT integrated pedagogy.
- It is noticed that, ICT integrated pedagogy allow visualization of mathematical concepts which helps students to link mathematical concepts in real life situation. This helps to promote lifelong learning.
- It is found that students rate of actively participation in classroom was increased in ICT enable pedagogy. Thus ICT can enhance learning engagement.

Conclusion

The advancement in the field of technology brought different changes in education sectors. Different ICT tools and ICT integrated pedagogy could be used for effective learning. ICT integrated pedagogy was new trend for Nepal. Information and communication technology (ICT) in Education Master Plan (2013-2017) allows for

the scaling-up the use of ICT in school education. Different policies of government related to ICT were available in the field of education. These policies focus on the use of ICT tools in teaching and learning process but gave less concern for improving ICT infrastructure in schools, human resource management, curriculum integrated ICT. Currently, among 29,607 community schools only 28% schools have computer facilities. About 44% schools have used ICT in teaching and learning which have computer facilities.

Many researchers showed that use of ICT in teaching and learning process helps for effective learning. In context of Nepal, ICT tools were gradually used in teaching and learning process. There were some challenges arise when practicing ICT integrated pedagogy in limited sources. Inadequate presence of ICT infrastructure and disabilities related to vision problem created challenges in classroom management. Moreover, geographical intricacy caused problems to electricity; poor connection of internet also challenged in ICT integrated pedagogy. Similarly, fewer opportunities of ICT related trainings hinder teachers to update with new technology. Sometime teacher felt burden to use ICT integrated pedagogy due to the lack of enough time to prepare files for classes. Curriculum has not mentioned how and what types of ICT tools as well as software could be used in teaching which made confusion for teacher. Also less concern of SMC as well as school administration challenged for ICT integrated pedagogy.

On the basis of above findings I can say that ICT supports students for conceptual learning. Students have positive attitude towards learning mathematics in reference with use of ICT. Consequently, the ICT also encourages students to learn mathematics in more enjoyable and interesting way. Apart from this, Geogebra is the

best tool to visualize mathematical concepts and use of Geogebra in mathematics teaching can make the learning process more effective as well as enhance the student's capabilities in understanding basic concepts and link the concepts with their surroundings. Therefore, from the policy level, the use of ICT should be promoted and gave concern for improving ICT infrastructure. Moreover, trainings related to ICT as well as matters related to ICT should be including in curriculum for promoting ICT integrated pedagogy. So that the qualitative achievement in mathematics is further be improved.

Implications

This study focused on exploring challenges encountered by teachers in ICT integrated pedagogy. The conclusion of this study could not generalize to all areas due to the limitation contained in this study. This study was conducted in rural area. Further research may be conducted in urban areas to investigate challenges faced by teachers in ICT integrated pedagogy. The following topics has recommended as the further research:

1. The use of ICT in mathematics teaching in urban area may also be conducted.
2. The practice of ICT integrated pedagogy in institutional school may also be conducted.

Implication for the policy level

Policy is the roadmap of curriculum design, which has affected by contemporary society, politics of nation, need of the society and international curriculum. Government of Nepal should develop mathematics curriculum and textbooks including ICT and provide ICT related trainings to all mathematics

teachers. The ministry of education should give concern for improving ICT infrastructure in school. Governmental bodies should encourage to the teacher to apply the ICT integrated pedagogy and teacher must get regular supervision must be need in the classroom.

Implication for practice level

ICT integrated pedagogy is student centered learning method. Students can learn mathematics in enjoyable and meaningful way with active participation. So, school can use ICT while teaching. ICT integrated pedagogy play role as the bridge to connect content and brain of students. ICT integrated pedagogy can be arrange to present in large classrooms as it provides maximum amount of variety and flexibility

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Appendix A– Interview Guideline

The interview with teacher was based on following aspects.

ICT enabled pedagogy

- Use of ICT tools in mathematics teaching
- Benefits of using ICT tools in mathematics teaching

Challenges in ICT enabled mathematics teaching

- Classroom management during ICT enabled mathematics teaching
- Electricity supply system
- Curricular challenges
- Time management
- ICT infrastructure and internet connectivity
- Financial challenges

Measures to cope challenges for promoting ICT enabled Pedagogy

- Related to policies and ICT infrastructure
- Related to classroom and time management
- Related to curriculum and content
- Related to financial support

Appendix B – FGD Guidelines

The FGD with students of grade 10 was based on following questions.

1. Which subjects does you like must? And which one is least?
2. How much time do you spend for mathematics learning at home?
3. Have you ever learnt mathematics through the use of ICT?
4. Do you use internet at home?
5. Do you use computer and internet for mathematics learning?
6. Have you heard about Geogebra software?
7. Do you use Geogebra software for mathematics learning?
8. How would you feel about using Geogebra?
9. Did the use of Geogebra facilitate your mathematics learning?
10. Did you get any differences with use of ICT and without use of ICT while learning mathematics?
11. Do you think, is the use ICT effective while learning mathematics? If yes, how? What changed?
12. In your opinion, what are the problems of ICT enabled mathematics teaching?
13. Do you think, what measures will be implement to diminish problems of ICT enabled mathematics teaching?