PEDAGOGICAL DISCOURSE IN MATHEMATICS CLASSROOM

Boj Bahadur Budhathoki

A Dissertation for the Degree of Doctor of Philosophy in Education

Submitted to

Office of the Dean

Faculty of Education

Tribhuvan University

Kathmandu, Nepal

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ABSTRACT

The study of pedagogical discourse in mathematics classrooms was aimed to explore the current situation of existing mathematics classroom discourse, oversee the challenges, unearth the engagement of students and teachers in pedagogical activities in culturally diverse classrooms, and uncover the methods for promoting student-friendly mathematics classroom discourse. A qualitative ethnographic method was applied within the constructivism paradigm linking with, existing relevant theories, and various scholarly works of literature to accomplish the study. The existing multifaceted realities were explored by analyzing the sequential process of transcribing, coding, categorizing, and thematizing the datasets obtained from the methods of classroom observations, in-depth interviews, and focus group discussions. This study has applied Bourdieu's cultural capital theory, Vygotsky's sociocultural theory, Gardner's multiple intelligence theory, and Freire’s critical pedagogy theory while preparing the theoretical and conceptual framework and used thematic analysis methods during the data analysis part.

The results showed that mathematics teachers used the writing of the mathematical formulae on the whiteboard, problem-solving, questioning the students, and answering the questions as a regular classroom activity, and beyond that, they also applied interactive pedagogical approach that engaged students in discussion, debate, interaction, and logical reasoning with ample examples in the classroom. Instructional discourse in mathematics education was worthwhile and collaborative in small groups, writing-centered, systematically planned, and organized in generating and transferring knowledge between students and teachers. In systematic, creative,

and inspired communication, mathematics teachers have shown to be competent, diligent, experienced, and skilled in the areas of knowledge creation and transfer related to cultural contexts in culturally diverse classrooms. Although the mathematics teachers realized that the mathematics curriculum and textbooks were not integrated into line with the local and native cultures of real life, the teachers spared no effort to enliven the classroom discourse by orchestrating plentiful examples of incorporating existing cultures into relevant topics. Mathematics teachers integrated some of the existing cultural practices into mathematics as much as possible by involving students in lessons, drawing diagrams, collaborating with classmates, constructing teaching-learning materials, answering questions, reasoning, and dealing with fieldwork and laboratory work. The classroom discourse was innovative through these ideas: motivational and creative teaching methods, a fearless environment, student-friendly pedagogical approaches, and impeccable ICT-integrated teaching methods.

However, teachers and students faced many challenges in the mathematics classroom in a multicultural environment. Although the community schools implemented an English-medium teaching method, teachers and students were not prepared to teach and learn in the English medium. This language mismatch further complicated the organization of classroom discourse. Classroom discourse was only a bilingual practice of Nepali and English although class members functioned as a miniature multilingual society, where marginalized student groups felt threatened and dominated by the culture and language of the larger groups. In such a situation, even though the teachers tried their best to make the classroom discourse meaningful; cultural and linguistic contradictions unexpectedly existed. Learning difficulties were encountered as a result of frequent student absences. The presence of large numbers of students in some classrooms made it inappropriate to correct classroom tasks and engage students equally in mathematics classroom discourse. The integration of ICT enhanced the pedagogical discourse to understand the basic concepts of mathematics although some old-aged teachers faced challenges in integrating ICT into mathematics teaching because they were given little in-service training to use the latest ICT tools which were not enough to cope with the modern tools in education. There was no adequate system for training teachers to teach mathematics in multicultural classrooms.

The findings of this research can be employed in policy-level implications, program implications, pedagogical implications, motivational implications, theoretical implications, and training implications.

DEDICATION

I would like to dedicate this work to the entire of my family members. Special dedication goes to my beloved parents Nara Bahadur Budhathoki and Hira Maya Budhathoki for their encouragement, support, and nurturing with love, care, and freedom. Finally, and most importantly, I dedicate this work to an integral part of my life, Tara Devi Budhathoki, and sons, Omraj Budhathoki and Shivam Budhathoki for everything they have given me and shared with me throughout this journey.

DECLARATION

I hereby declare that this dissertation entitled " Pedagogical Discourse in Mathematics Classroom" submitted to the Dean's office, Faculty of Education, Tribhuvan University is a completely unique work. While writing this dissertation, I have given proper acknowledgments to all the ideas and information taken from various sources. The result presented in this dissertation has not been presented or submitted anywhere else for the award of any degree or any other reason. No part of the content material of this dissertation has ever been posted or published in any format before. I shall be solely accountable if any proof is observed in opposition to my dissertation. I confidently apprehend that my dissertation forever be preserved as a unique document of the everlasting series of Tribhuvan University Library. My signature underneath authorizes the discharge of my dissertation to the fascinated readers upon their request.

Boj Bahadur Budhathoki,

Ph.D. Candidate

October 2023

RECOMMENDATION

The undersigned certifies that I have read and recommended to the faculty of education, Tribhuvan University for the final acceptance of a dissertation entitled "**Pedagogical Discourse in Mathematics Classroom**" submitted by **Boj Bahadur Budhathoki** in partial fulfillment of requirements for the degree of **Doctor of Philosophy in Education.**

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Prof. Bed Raj Acharya, Ph.D.

Dissertation Supervisor

October 2023

DISSERTATION APPROVAL

The dissertation entitled "Pedagogical Discourse in Mathematics Classroom" submitted by Boj Bahadur Budhathoki for the degree of PhD has been examined and approved. This dissertation has been approved by

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LIST OF ABBREVIATIONS

CBS:	Central Bureau of Statistics
CDC:	Curriculum Development Centre
COVID:	Coronavirus Disease
ECD:	Early Childhood Development
ECD:	Early Child Development
ERO:	Education Review Office
FoE:	Faculty of Education
GSE:	Graduate School of Education
MoE:	Ministry of Education
MoEST:	Ministry of Education Science and Technology
NASA:	National Assessment of Student Achievement
NCED:	National Centre for Education Development
NCERT:	National Council of Educational Research and Training
NCF:	National Curriculum Framework
NCTM:	National Council of Teachers of Mathematics
NEB:	National Examinations Board
PIRLS:	Progress in International Reading Literacy Study
PTA:	Parent Teacher Association
SEE:	Secondary Education Examination
SLC:	School Leaving Certificate
SMC:	School Management Committee
SSDP:	School Sector Development Plan
SSDP:	School Sector Development Plan

TIMSS: Trends in International Mathematics and Science Study

TPD: Teacher Professional Development

UNESCO: The United Nations Educational, Scientific and Cultural Organization

CHAPTER I

INTRODUCTION

In this chapter, first I introduced the study context. Then, I outlined the problem statement, objectives of the study, and research questions with their rationale. My experience of student life in mathematics teaching/learning and the current national and international context of mathematics teaching and learning helped me identify the problem statement and research questions.

The Personal and Local Context

When I was a school student, I was taught mathematics very rigidly. There was hardly any other work in didactic mathematics apart from memorizing large numbers of formulae, geometrical theorems, and complex calculations using those formulae. Mathematics had to have a very formal structure. Mathematics was less integrated with other subjects across the curriculum. My teachers always encouraged me to memorize everything in mathematics such as tables, equations, rules, and formulae. They expected me to learn mathematical concepts and terminologies by rote memorization. There was only one acceptable way to solve the problem in mathematics. Now, I cannot remember my teacher, teaching us by using teaching materials. We were not given any practical strategies for learning mathematics. As I was a student in grade ten and going to appear for the School Leaving Certificate (SLC) examination, my mathematics teacher motivated me to learn everything committal to memory telling me "*even if you forget your own name, never forget this formula*". Therefore, I could not solve any problem in mathematics by going beyond what I was exactly taught in the classroom. Mathematics was primarily about figures and word problems were seldom used. Our mathematics class used to be “pin-drop silent” and we used to speak with our teacher only if he asked questions.

There was univocal mathematical discourse mixed with teacher domination and punishment (Otten, Engledowl, & Spain, 2015). Many of my classmates suffered from mathematics anxiety and some of them dropped out of school. We learned mathematics theoretically and monotonously, amid fear, punishment, rote memorization, and lack of teaching materials. Not only our class but almost all the mathematics classes used to be similar. Teachers’ evaluations from students’ perspectives used to be positive of his/her rigidity and sternness toward the students in the classroom (Politis, 2004). Many students used to say “Sara ṭā kyā khaṭārā hunahunchā, chu'ikka bōlanā pānī dinū huḍā'inā” [1][This teacher is so strict, even a single word is not allowed to speak]. To this ground, a question triggered me, was it a unique way to teach/learn mathematics or are there alternative ways of teaching/learning mathematics that are not as rigid, or formal, and emphasize rote learning?

National Context of Teaching and Learning Mathematics

I have been teaching mathematics at the high school and college levels for over a decade and a half. I found that most of the students were less interested in learning mathematics. Not only my experience but my colleagues teachers have also had similar experiences in learning mathematics. In every annual exam, many students score low in mathematics and need grace marks to be promoted to the next class. Mathematics teachers felt that students who were particularly weak in mathematics were promoted to higher levels and that they were not suitable for that

[1] Romanized Nepali language.

level. The results of the Secondary Education Examination (SEE) have shown lower achievement in mathematics each year, despite higher concentration having paid off for betterment. Similarly, the study by the Education Review Office (ERO) showed low achievement in mathematics in class 3, class 5, class 8, and class 10 in the years 2011, 2015, 217, and 2019 respectively (Education Review Office [ERO], 2013; 2015; 2015a; 217; 2019). The ERO study indicated, that 32 out of 100 students fall below the basic level in mathematics achieving only 5% of the tested curriculum and at the basic level, about 40% of students have achieved only 28% of the tested curriculum. More than 70% of students have achieved only below 28% of the tested curriculum in mathematics indicating a huge mass of students underperforming in this subject (ERO, 2019).

The National Centre for Education Development (NCED) under the Ministry of Education, Science, and Technology is undertaking activities related to teacher development, and capacity development of educational personnel conducting research activities in education. Although, NCED deals with all aspects and levels of teacher training, and management and professional training, the approach and efforts could not be more realistic, effective, and efficient. During and afterward the COVID pandemic, NCED provided video lectures on some subjects including mathematics through websites, social media, radio, and television broadcasting to facilitate education. However, these lecture materials are limited in students due to the unavailability of internet and device facilities among the children. Video lectures were recorded in a student-less cabin and they followed the univocal, unidirectional, and monotonous speech with few demonstrations.

To overcome the decreasing performance scenarios of students, the Curriculum Development Centre (CDC) has recently developed the National

Curriculum Framework (NCF), 2019 to address the changed socio-political condition of the country and the current needs of the learner. The NCF, which is a guiding and dynamic document of the school education system, has emphasized the mother tongue as a teaching-learning activity at the basic level (grades 1-3). It has adopted an inclusive approach and emphasized a continuous assessment system at the basic level (grades 1-8). Learning activities of early childhood education should be conducted informally in a manner that provides opportunities for independent learning based on individual differences and abilities of children. While conducting the learning facilitation process, student-centered and child-friendly teaching methods should be adopted and emphasis should be placed on continuous learning rather than teaching. Student learning should be considered as the centre point and learning facilitation activities should be conducted through observation, group work, project work, field visits, story-telling, character performance, problem-solving, and discovery-based studies. Currently, the curriculum and textbooks are being developed and implemented at various grades based on the national curriculum framework in Nepal.

Mathematics Discourse in Classroom

Conversation (language) is one of the widely used ways of sharing and creating knowledge in the world in any of the disciplines. Mathematics is also a discipline that uses a lot of conversation, negotiation, and logical debate. One of the most important mediums for communication is talking about mathematics, which is often referred to as *discourse* (Behnam, 2009). Discourse is not just any talk about mathematics; meaningful discourse includes students comparing and contrasting ideas and methods, constructing viable arguments, critiquing each other’s reasoning, and helping each other make sense of mathematics (Ballard, 2015). Mathematical classroom discourse is about whole-class discussions in which students talk about mathematics in such a way that they reveal their understanding of concepts.

Students also learn to engage in mathematical reasoning and debate (Christie, 1998). Discourse is the meaning-making process from the interaction between students and teachers in the classroom in mathematics teaching and learning. In many practices of our classrooms, teachers just write some relational formulae concerning variables and make students just memorize and replace values on the formulae. In such practice, mathematics learning students have a weak base and they have a habit of doing mathematics without understanding it well. Cultural pluralism (Khanal, 2017) has added much complexity to teaching mathematics to high school-level students. It is beneficial to involve every student in the discourse as much as possible to enhance the understanding level of students. Mathematical discourse includes the special dialect of mathematicians use to communicate mathematical reasoning and the vocabulary that describes the behaviour of mathematicians and students when doing mathematics as well as their attitudes toward various aspects of mathematics (Wells, 2002). Mathematical discourse is quite different from other discourses because it uses symbolic and variable interactions in logical understanding.

Discourse plays a vital role in classroom activities in developing countries because there are fewer alternative pedagogical practices. We see a continued emphasis on classroom discourse as pivotal to current reforms in mathematics education because discourse informs not only our understanding of students' thinking about mathematics but also teachers' thinking about teaching mathematics. As such, our purpose is to explore more closely the link between classroom discourse and teaching-learning mathematics (Blanton, 2001; Blanton, Berenson, & Norwood, 2001). Discourse involves asking strategic questions that elicit from students both how a problem was solved and why a particular method was chosen. Students learn to critique their own and others' ideas and seek out efficient mathematical solutions (Knott, 2008). The pedagogical discourse in the mathematics classroom is mathematically significant, it is analyzed in terms of whether the positioning and timing are right to create a pedagogical opening (Long, 2015). While classroom discussions are nothing new, the theory behind classroom discourse stems from constructivist views of learning where knowledge is created internally through interaction with the environment (Contreras, 2006). It also fits in with sociocultural views on learning where students working together can reach new understandings that could not be achieved if they were working alone.

Classroom discourse is one of the powerful tools for teaching mathematics in developing countries like Nepal because there are fewer alternative pedagogical practices exercised but it varies in developed countries. In the classroom, the teacher's talking plays a much more important role in students' learning in a diverse atmosphere - racially, ethnically, and linguistically (Blanton, 2001; Khisty, 2002). Furthermore, Behnam (2009) illustrates classroom discourse as a special type of discourse that occurs in classrooms. Classroom discourse includes unequal power relationships, turn-taking at speaking, patterns of interaction, etc. that develop a positive attitude toward students. Classroom discourse is often different in form and function from the language used in other situations because of the particular social roles that learners and teachers have in classrooms and the kind of activities they usually carry out there (Kiemer, 2015). Thus, mathematical discourse is the meaningful conversation between teachers and students to share the necessary knowledge about a certain field or topic in the related subject areas. The above works on the role of discourse and mathematics learning inspired me to understand the classroom discourse and transfer of knowledge in the field of teaching-learning mathematics.

Developing Innovative Learning Methods from Classroom Discourse

Meaningful discourse in mathematics class is essential for student learning. Mathematical discourse helps students reflect on their understanding, make sense of critique the reasoning of others' ideas, and build up mathematical confidence. This shares more information about the importance of mathematical discourse, what good mathematics discussion looks like, and strategies one can try now to improve the discussion in the classroom. Talking about mathematical concepts allows students to reflect on their understanding. When done in a collaborative and supportive learning environment, this can support the achievement of higher-order thinking skills, and standards for mathematical practice. In the line of developing innovative mathematical methods, Shrestha, Luitel, and Belbase (2021) claim that students can make conjectures, link prior knowledge to current understanding, reason about mathematics, refine and amend their approaches, and take ownership of their mathematical knowledge.

Students benefit greatly from learning to use the tools of mathematical discourse including words, symbols, diagrams, physical models, and technology to present and defend their ideas. Imparting these new skills in students allows teachers to access, monitor, and evaluate students' mathematical understanding and development (Wagner, Herbel-Eisenmann, & Choppin, 2011). One approach to giving students the information for a mathematics lesson involves student engagement that encourages a productive dialogue. As educators, we need to structure lessons to encourage student interaction, address gaps in student understanding, and help students express mathematical concepts more precisely. Providing an opportunity for conversation ensures the enrichment of knowledge. Facilitating student engagement in mathematical discourse begins with the decisions of teachers and their plans of classroom instruction; the tasks they use, how they organize the classroom, and the behaviours of communicating expressions, including the ways of students' engagement.

To support students, teachers must help students create a vision for expected behaviours and actions, prepare them for their roles by modeling or role-playing, and reinforce these behaviours consistently. Teachers need to monitor progress as students engage in mathematics discussions, supporting them as their mathematical knowledge grows and they become more skilled at expressing ideas collectively and using vocabulary, syntax, and semantics precisely.

In addition to content knowledge, mathematical discourse allows teachers to monitor students' dispositions and gauge the development of confidence, interest, and dedication in students. Teachers can use this information to determine areas of confusion or frustration to decide when intervention might be needed. They also examine understandings and misconceptions revealed during classroom discussions and adjust lesson plans accordingly. While it is important to build scaffolds to support students who are learning English and mathematics at the same time, it is essential to recognize that mathematics is a technical language that all students must learn. Students who are English speakers also require support as they learn the language of mathematics.

Mathematical discourse is the way students represent, think, talk, question, agree, and disagree in the classroom. It helps students reflect on and make sense of their understanding of mathematical concepts. Perhaps most importantly it builds confidence for learners. The mathematics classroom is often a challenging space for learners. Students can be very sensitive to getting wrong answers. There is also the uncertainty that comes from not knowing how to explain something or communicate their misunderstanding. In this situation, I think, mathematical discourse is only the right solution to the problem.

In this situation, the discussion between teachers and students, students-students, and teachers-teachers play a vital role in constructing mathematical knowledge so that the issue of classroom discourse in culturally diverse mathematics classrooms is suitable for carrying out the research. Therefore, I was motivated to carry out the research entitled “Pedagogical Discourse in Mathematics Classroom”.

Problem Statement

I have been teaching mathematics in school as well as college-level students for more than a decade and realized that students generally have weak mathematics backgrounds and suffer from high anxiety and they need and demand a great deal of support. At the same time, many of them are highly motivated, and it is often possible to witness positive changes throughout the term in both their mathematical abilities and their affective states—changes that have the potential to reach beyond and through these students, to influence the mathematical experiences of future pupils. In my teaching profession, I have witnessed some problems as stated below.

Problem 1: Low Achievement in Mathematics

One of the most contrasting problems in Nepal is low achievement, especially in subjects like Mathematics, Science, and English. An analysis of SLC results over ten years (1995 to 2004) showed an average failure rate of 60%. A closer look at the 2001 SLC results showed that public school students perform shockingly poorly, with a 25.4% pass rate compared to private school students (75.3%) (Mathema, 2007). The School Leaving Certificate (SLC) examination has been a major concern to the state, society, schools, parents, and students as it is the gateway to the world of higher education. Each year, thousands of students cannot pass the SLC exam and find themselves stumbling blocks in the path of pursuing higher education and career development. In the year 2013 BS, over 335,000 students could not cross this threshold in mathematics examination (Budhathoki et al., 2014). The Ministry of Education (MoE) of Nepal (2014) reported that SLC dropouts face difficulties getting through Mathematics, English, and Science. The failed percentage of students in mathematics in 2010 was 29.62%. In 2011, it was 38.79%, and in 2012, it was 42.09% (MoE, 2014). It also showed that a large number of students failed in mathematics in the SLC.

The performance of most of all community school students (66%) is under a satisfactory level than private and they (85%) were very poor in Mathematics subjects than others. There is also a wider gap in student performance between theory and practical subjects. Students from municipal government and Brahmin/Chhetri ethnic groups are doing better performance than others (Chapagain, 2020). As per the data of MoEST (2019), there were 27704 (80%) community schools and 6787 (20%) private schools in Nepal. Altogether 34491 schools are being managed by 753 local governments in Nepal after devolving power and jurisdiction on the school education system by a new constitution promulgated in 2015.

After the establishment of the Education Review Office, under the Ministry of Education, the National Assessment of Students Performance (NASA) was also conducted in grades 3, 5, 8, and 10 in different academic years from 2011 to 2019 and the reports showed that student performance is under preference level in all grades and socio-demographic factors play the significant role students' performance (ERO, 2019).

According to Mathema and Bista (2006), “Most of the failures in the SLC examination can be attributed to a failure in mathematics” (p. 151). The teaching-learning process primarily focused on memorizing mathematical facts and procedures without knowing the concepts and applications. The factors for failing in the SLC examination in Mathematics, English, and Science were poor teaching-learning environment in public schools, lack of qualified and competent teachers, lack of coaching to support students, lack of remedial classes for the students, traditional didactic teaching practices, and poor coordination among school teachers, parents, and students (Shrestha, Luitel, & Belbase, 2021).

There has been sustained low performance in mathematics historically and has not been improved yet despite new policies and plans. The reason there is not much change in teaching that emphasizes discourse or focuses on the problem is that these failures might point to the lack of appropriate discourse in classroom practices that might have impacted students' learning and performance in mathematics.

Problem 2: Disengaged Teaching and Learning of Mathematics

Student engagement is very necessary for the subject matter of mathematics to produce a satisfactory result or output in the examination. Engagement is exceptionally important, without engagement students have limited opportunities to participate in the curriculum, however, increased engagement in itself can increase the number of students who continue with mathematics (Attard & Holmes, 2019). In every grade of mathematics teaching and learning, students are found to be disengaged from the context of learning. They used to be present in the classroom by their body not by souls. The rapid decline in learning habits among students indicates that something is missing in the existing teaching-learning process. The alarming factors in the Nepali context were: failure to connect the science and maths lessons with the real society, fixed but negative mind-set of the parents and their kids towards the output of the subjects, lack of intervention from the policymakers and educationists and mismanagement of the science and maths products among others (The Himalayan, 2017). Interesting and student-friendly classroom discourse is lacking or insufficient in the mathematics classroom to engage all the students spontaneously.

Problem 3: Decontextualized Teaching and Learning of Mathematics

Nepal is a multicultural, multilingual, and multiethnic society with diverse economic disparities (School Sector Development Plan, Ministry of Education [MoE], 2016) and it is a matter of concern that education is to develop and transmit 'cultural values that are important for the property and dignity of our society (Acharya, 2017). The reflection of cultural activities and social potentials in the Nepalese education system is still a common practice through classroom discourse.

According to the Constitution of Federal Democratic Republican Nepal (2015), every child has the right to learn in his/her own mother tongue, and each person and society is responsible for protecting the child's right to create an egalitarian society through equitable education. Embracing multi-caste, multi-lingual, multi-cultural, and diverse social stratifications, teachers have a crucial role in providing contemporary education to every child to protect and promote unity in diversity, social and cultural solidarity, and harmonious attitude. As a teacher, this helps me to understand that the types of discourse that do not recognize diversity in the classroom are not only inappropriate and insufficient but it is also irrelevant (Jaeger & Mollegaard, 2009; Khisty, 2002; Saengpun, 2013). In this context, Nepali classrooms are culturally, socially, economically, geographically, gender, linguistically, and religiously diverse, but our classroom discourse is monotonous, didactic, and influenced by the Western environment. This irrelevant teaching and learning of mathematics content have widened the gap in teacher delivery and access to similar materials.

Problem 4: Lack of Teacher Professional Development for Classroom Discourse

In Nepal, there are two types of teacher training conducted by two different institutions; universities and the Ministry of Education. The National Centre for Educational Development (NCED) runs in-service teacher training programs at the primary and secondary levels, and these programs vary in duration from a few weeks to ten months. NCED also runs primary teacher training programs through its affiliated primary teacher training centres (Gautam, 2016). Equally important is improving the teacher's confidence and skills in dealing with students. No element is more important for student success than excellent teaching. Good buildings, types of equipment, and textbooks are important, but it is the skill and commitment of the teacher that create the learning space. (Hickok, 1998). The Government of Nepal has invested large amounts of resources in teacher training, as it believes that training will develop effective teaching skills in teachers and that they can use these skills in the classroom so that students can achieve better results. However, it has been shown that very little success has been achieved in this area in recent decades. (Gautam, 2016).

The joint involvement of parents, community members, SMC and PTA members, government representatives from local authorities, and the district education department could encourage teachers to develop and/or implement the local, integrated, and contextualized curriculum at the school level. But this type of collaboration is far behind in Nepal (Dhungana, Luitel, Gjøtterud, & Wagle, 2021). The Teacher Professional Development Program (TPD) in Nepal is a very ambitious program that aims to encourage teachers for their professional development. The TPD program is very well and perfectly designed for the professional development of Nepalese teachers, but there are many gaps in the different steps of the program's implementation, which in the case of teacher training appears to lead to the TPD program's failure since training transfer was discovered to be very less effective (Kshetree, 2021). The teachers' professional development in Nepal is lacking in teaching mathematics effectively in the classroom.

Problem 5: Lack of Curricular Resources to Promote Discourse

Although Nepal is a geographically diverse country, even though the socio-economic background is not the same across the country, the same mathematics curriculum has been implemented in the country. Textbooks, teacher guides, and reference materials are essential for the effective delivery of content. Even in schools in rural areas, textbooks are not distributed on time and access to other materials has not been thought about. In this context, effective teacher training is necessary to develop teaching materials, resource materials, and their use and storage for future use. Due to the lack of textbooks, and resource materials, the classroom discourse on mathematics has not been effective despite the full effort of the teachers.

Objectives of the Study

The major objective of this research is to explore classroom discourse within a mathematics classroom in a culturally diverse classroom.

The specific objectives of this study were:

1. To explore the existing mathematics classroom discourse in school-level students.
2. To investigate the engagement of students and teachers in conducting classroom discourse, in a culturally diverse classroom.
3. To explore the strategies for promoting student-friendly mathematics classroom discourse.
4. To explore the challenges experienced by mathematics teachers and students while conducting pedagogical discourse in mathematics.

Research Questions

Generally, research questions have to be answered through research activities. So, it is considered that research questions are the guidelines to determine the information collection procedure, field activities, and findings with conclusions. This study intends to find the answers to the following research questions.

1. How is the existing classroom discourse of mathematics teachers in the mathematics classroom?
2. How do teachers engage themselves in promoting meaningful classroom discourse in the mathematics classroom?
3. How do teachers motivate the students during the classroom discourse?

4. How can teachers make classroom discourse students-friendly, in a culturally diverse classroom?
5. How do teachers and students experience the challenges of engaging in mathematics classroom discourse?

The Rationale of the Study

Nepal is a multicultural, multilingual, and multiethnic country and is undergoing a political, social, and educational transformation (MoE, 2016). In this context, it is necessary to review the classroom teaching techniques and adopt appropriate and student-friendly teaching methods. The conclusions drawn from such type of research are very helpful in understanding the learning struggle of students and the challenges faced by teachers through dialogic processes in multicultural settings (Budhathoki, 2020). Especially, this study is very much fruitful to the teachers, educationists, NGOs, and INGOs working in the field of education. This study also helps the people concerned with education to understand the teaching-learning process in mathematics that goes on in the classrooms. Technology has allowed us to deeply personalize the mathematics experience for students and teachers to get the opportunity to learn with and from peers.

Community conversations are a great way to build collaboration skills, open the door for a productive role, and highlight the beauty of problem-solving from a variety of perspectives. From the meaningful discourse in the mathematical classroom, logical thinking, debating, problem-solving skills, participation, group work skills, and self-dependency skills can be grown in students. Most of the students are weak in mathematics due to the lack of proper discussion in the classrooms and at home. A report of a national assessment of achievement in the years 2011, 2012, 2013, and 2015 showed lower achievement in mathematics than in other subjects.

Education Review Office [ERO] surveyed 246860 students from 6465 schools of 75 districts in classes 3, 5, and 8 and hence found that average achievement in mathematics is lower than international standards referencing the TIMSS and PIRLS (ERO, 2013, 2015, 2015a, 2016, 2017). Furthermore, the National Assessment of Student Achievement (NASA) tested the learning outcomes of class 10 students in Mathematics, Science, Nepali, and English in 2019. A nationally representative sample of 43886 students from 1800 schools in Nepal including seven provinces also showed lower achievements in mathematics compared to other subjects (ERO, 2020). From the above discussion, it is clear that there is something insufficient in delivering knowledge from teachers to students. The aspirations of teachers and students are getting divergent instead of convergent to the same ascent.

After a long brainstorming, I came to the point that classroom discourse is the way through which pedagogy is improved. I think pedagogical discourse in the mathematics classroom is researchable and tries to seek a better way of learning with few modifications of established methods without cost. It can further enhance the teachers' teaching methods by enriching strong and self-sustaining guidelines. The result of this study helps policymakers and curriculum designers to adjust the ascent of cultural pluralism in the curriculum of mathematics. It is equally helpful for mathematics teachers to understand artefacts of cultural pluralism during a teaching in a multicultural classroom. It adds up to a new horizon in the field of research in mathematics in the context of Nepali society. The findings of this inquiry are beneficial for all the stakeholders of the present education system of Nepal. Therefore, it is a fully rational choice to carry on this research in the context of multicultural classroom settings.

Delimitation of the Study

This is a qualitative study, using the ethnographic approach. The purpose of this research work was to fulfill the academic degree of Doctor of Philosophy in Education Studies, and of course, some constraints of a time interval, available information, logistic support, and area of study had shrunk the inquiry. Under the above-mentioned circumstances, I have encircled this study on the following boundaries:

i. This study was delimited into four community schools in the Kathmandu Valley of Nepal.
ii. The study was focused on the pedagogical perspective of discourse in mathematics classrooms in school-level teaching and learning.
iii. This study involved only students, mathematics teachers, head-teachers, and mathematics educators.
iv. The findings of this study were based on a qualitative design with an ethnographic approach.

Definition of Key Terms Used in the Study

I have used the terms mentioned below and their meaning and understanding may differ unless I specify them.

School-level children. School-level children means all the children studying from class six to class ten are taken as school-level children. Although ECD to class twelve is taken at the school level according to the latest (ninth) amendment of the Education Act 2028 in 2074 BS, only those students who are studying at least class six to ten can actively participate in the mathematics discourse and understand the culture. Furthermore, in my experience of teaching mathematics, class six to ten students can make good critical and analytical conversations with my research questions.

Discourse. Discourse is the communication between teacher and student or among the students to facilitate understanding of specific topics given in the textbook during the classroom teaching-learning activities. In this study discourse is the logical oral and written conversations and interactions made between teacher and students, students and students and the method followed in teaching-learning mathematics in the classroom.

Mathematics classroom discourse. Mathematics discourse is about whole-class interactions in which students talk about mathematics in such a way that they reveal their understanding of concepts. The mathematical discourse includes students comparing and contrasting ideas and methods, constructing viable arguments, critiquing each other's reasoning, and helping each other make sense of mathematics. Mathematical discourse is the meaning-making process from the interaction between teacher and student or student and student to conceptualizing and understanding the symbols, logical operators, or mathematical operators in the process of learning and teaching mathematics.

Discourse practice. The term in this research refers to the whole process of social interaction which includes language form (written and spoken), a pattern of interaction among the students and teachers as well as the values embedded in the use of language and the power relations and attitudes to knowledge.

Ethnic groups. Ethnic groups are the classes of people who identify with each other based on similarities such as common ancestry, language, history, society, and cultural activities. Belonging to an ethnic group is shared cultural heritage, ancestry, myths of origin, stories, hometowns, languages, or dialectical symbols such as religion, myths and rituals, food, dress, art, and physical appearance. An ethnic group may also be the social stratification in a heterogeneous population according to some specific characteristics.

Pedagogy. Pedagogy is the discipline that deals with the theory and practice of teaching and how these influence student learning. Pedagogy informs teacher actions, judgments, and teaching strategies by taking into consideration theories of learning, understanding of students and their needs, and the backgrounds and interests of individual students. Pedagogy includes how the teacher interacts with students and the social and intellectual environment the teacher seeks to establish.

Culture. Culture is the characteristics and knowledge of a particular group of people (students and teachers), encompassing language, religion, cuisine, social habits, beliefs, customs, practices, and social consistency or lifestyle.

Multicultural mathematical discourse. Multicultural mathematics discourse is a style of teaching mathematics that incorporates different cultural perspectives, values, and beliefs. It is an approach to teaching mathematics that takes into account the diversity of students in the classroom and looks for ways to include their culture in the classroom. This type of teaching can help bridge cultural gaps that exist between students and create a more inclusive learning environment.

Mathematics educators. Mathematics educators are university teachers with a minimum of a master's degree in mathematics education. Mathematics educators may be involved in curriculum planning and authoring of mathematics textbooks.

Old-aged teachers. According to the head-teachers of community schools in Nepal in this study, old-aged teachers refer to those teachers who are going to take their retirement at the age of 60 years.

Pedagogical discourse. Pedagogical discourse in mathematics refers to the language, interactions, and discussions that take place in the context of teaching and learning mathematics. It encompasses the ways in which teachers communicate mathematical concepts, strategies, and procedures to students, as well as the ways in which students engage with and respond to this information.

Chapter Summary

In this chapter, I explored how I was taught mathematics and what inspired me to conduct related research, by making connections between my past mathematics learning situations and my experiences as a school-level student. In reshaping my idea, I have raised some insightful issues regarding mathematics discourse. My core issue is mathematics classroom discourse, how it is going on, and how should it be in a multicultural setting. To make my ideas and topics researchable, I presented problems meaningfully that had been buzzing around in my head, which haunted and led me toward research work. I stated four research objectives to be achieved upon completion of the study and identified five research questions to guide those objectives. I also presented the rationale for this study, along with an overview of several supporting documents on pedagogical activities in mathematics teaching and its achievement. I believe that my research would be fruitful and prove to be a milestone for all stakeholders in mathematics education, adding a new building block to the field of mathematics research in the context of Nepal.

CHAPTER II

LITERATURE REVIEW

In this chapter, I focused on the literature review that appraises, encapsulates, compares, contrasts, and correlates various scholarly books, research articles, and other relevant sources that are directly related to the ongoing research work (Randolph, 2009). In doing this, I would like to create a sense of rapport with the readers that makes them trust the scholarly work by integrating up-to-date information about what has been done in a particular area of the study.

Randolph (2009) further states that conducting a literature review is a means of demonstrating an author's knowledge of a particular research area, including vocabulary, theory, key variables and phenomena, and its methods and history. In this section, I used a situated and sociocultural perspective to examine descriptions of mathematical discourse and my experience of student talk in a mathematics classroom. I have reviewed the literature by organizing thematic, empirical, and theoretical perspectives related to my study.

Theoretical Concepts Associated with this Research

I have conducted a thematic review of relevant literature as one of the most common forms of review in qualitative research that emphasizes pinpointing, examining, and recording themes within information (Thomas & Harden, 2008), with a variety of approaches, rather than a singular method (Saini & Shlonsky, 2012). I have thematized major concepts of envisioning classroom discourse, discourse in a mathematics classroom, forms of classroom discourse, power of discourse in mathematics, discourse as a pedagogical approach, mathematics learning through discourse, mathematical discourse within cultural diversity, and ethno-mathematics in classroom teaching.

Envisioning Classroom Discourse

Communication is one of the most widespread ways of sharing and creating knowledge in all areas of the world. Mathematics is also an area that uses a lot of dialogue, conversation, and logical reasoning. One of the most important communication media in mathematics pedagogy is classroom discourse (Behnam, 2009). Discourse is not just about talking in the mathematics classroom for student engagement. Meaningful discourse involves students comparing and complementary ideas and methods, constructing workable arguments, critiquing each other's arguments, and helping each other understand mathematics (Ballard, 2015). Mathematics classroom discourse is a class-wide discussion in which students talk about mathematics in ways that reveal their understanding of concepts. Students also learn to participate in mathematical reasoning and debate (Christie, 1998). Discourse is the process of meaningful interaction between students and students, students and teachers in the classroom while learning and teaching mathematics.

Mathematical discourse includes the special dialect of mathematicians use to communicate mathematical reasoning and the vocabulary that describes the behaviour of mathematicians and students when doing mathematics as well as their attitudes toward various aspects of mathematics (Wells, 2002). Mathematical discourse is quite different from other discourses because it uses symbolic and variable interactions in logical understanding (Gough, 2015). Discourse plays a vital role in classroom activities in developing countries. We see a continued emphasis on classroom discourse as essential to current reforms in mathematics education because discourse informs not only our understanding of students' thinking about mathematics but also teachers' thinking about teaching mathematics. As such, my purpose here is to investigate more closely the linkages between classroom discourse and learning to teach mathematics.

Discourse involves asking strategic questions that elicit from students both how a problem was solved and why a particular method was chosen. Students learn to critique their own and others' ideas and seek out efficient mathematical solutions (Knott, 2008). This mathematical analysis of the instance distinguishes our work from more general work on classroom discourse or even teachable moments in that we focus on instances that are likely to advance students' development of mathematical ideas. If an instance is mathematically significant, it is analyzed in terms of whether the positioning and timing are right to create a pedagogical opening (Ewing, 2017). While classroom discussions are nothing new, the theory behind classroom discourse stems from constructivist views of learning where knowledge is created internally through interaction with the environment (Contreras, 2006). It also fits in with sociocultural views on learning where students working together can reach new understandings that could not be achieved if they were working alone.

Underlying the use of discourse in the mathematics classroom is the idea that mathematics is primarily about reasoning, not memorization. Mathematics is not about remembering and applying a set of procedures but about developing an understanding and explaining the processes used to arrive at solutions (Day, 2016; Wells, 2002). Cobb and McClain (2005) claim that there are two parts to a mathematical explanation - the calculational explanation involves explaining how an answer or result has arrived at the process that was used. A conceptual explanation involves explaining why that process was selected – what are the reasons for choosing a particular way? In this way, students have to be able to not only perform a mathematical procedure but justify why they have used that particular procedure for a given problem. Furthermore, the rigorous mathematical knowledge sought at all levels of instruction requires deep thinking and persistent sense-making from students (Saengpun, 2013; Stein, Engle, Smith, & Hughes, 2008). Communication about mathematics among students and between students and the teacher is the vehicle for bringing thinking to the surface, clarifying ideas, moving ideas forward, revealing misconceptions, and making key mathematical connections clear, transferable, and memorable (Ballard, 2015). To turn a meaningful expression into a meaningful discussion teachers must employ effective talk moves such as, think time, wait time, turn-and-talk, think-pair-share, and think-write-pair-share. The motto of classroom discourse should be the right orientation toward the development of skills in mathematics in different classroom settings.

Classroom discourse is one of the powerful tools for teaching mathematics in developing countries such as Nepal because there are fewer alternative pedagogical procedures but it may vary and be quite different in developed countries. In developed countries, classroom discourse shows practical engagement with real-life problems but in developing countries, it remains less practical and more explanations, diagrams, and calculations. In the classroom teacher's talking plays a much more important role in students' learning in a diverse atmosphere - racially, ethnically, and linguistically (Blanton, 2001; Khisty, 2002). Furthermore, Behnam (2009) illustrates classroom discourse as a special type of discourse that occurs in classrooms. Special features of classroom discourse include unequal power relationships, turn-taking at speaking, and patterns of interaction. Classroom discourse is often different in form and function from the language used in other situations because of the particular social roles that learners and teachers have in classrooms and the kind of activities they usually carry out there (Kiemer, Gröschner, Pehmer, & Seidel, 2015). Thus, mathematical discourse is a meaningful conversation between teachers and students to share the necessary knowledge about a certain field or topic on the related subject matter. The concepts of different mathematicians developed insight in me and inspiration to understand the classroom discourse and transfer of knowledge in the field of teaching-learning in mathematics.

Discourse in Mathematics Classrooms

Talking about mathematical discourse, Moschkovich (2007) points to the complexity of mathematical communication in the classroom. Whether or not students' talk sounds mathematical depends on how we understand the distinction between daily life experiences and mathematical discourses. There are many authentic mathematical discourse practices. As analysts and teachers, we should not confuse 'mathematical' definitions with 'textbook' definitions; we should clarify the differences between mathematical ways of talking and formal ways of talking mathematically. Mathematically, talking intends to teach mathematical problem-solving methods, processes, techniques, and symbols used in a specific topic. We should remember that mathematical discourse practices are varied. Focusing on the structures of whole-class discourse and the relationship between these structures and the learning of mathematics, it has demonstrated that the teacher and the students jointly construct these discussions, yet the teacher retains a great deal of control, which they can use for particular pedagogical purposes (Ingram, 2012).

Discourse is an easy as well as a complex process of transferring knowledge. Mathematical discourse is a usual process in schools between teachers and students but there is a lack of authoritative discourse (Harbaug, 2005). Authoritative discourse is present in all social settings including but certainly not limited to school mathematics classrooms. Authoritative discourse practices of teachers, such as directive and definitive statements, can inhibit students' independent thoughts and actions unless these statements take a form such as 'you must think for yourself, 'you are going to argue that your answers are mathematically valid', or 'it is always the case that the explanations of your results are more important than the actual results. Pedagogical discourse in mathematics classrooms envisages me to interlink my issues, ideas, and research area. Pedagogical discourse in mathematics classrooms is an important part of the teaching-learning process (Khisty & Chval, 2002). It involves students engaging in meaningful conversations about mathematics topics, sharing their ideas and perspectives, and working together to solve problems. As a researcher, I can use classroom discourse to explore how students interact with each other and the material, as well as to identify areas of difficulty or misunderstanding. I can also use classroom discourse to explore how students use language to communicate mathematical concepts and to identify areas of potential.

The Benefit of Classroom Discourse in Mathematics

As we know one-sized shoe does not fit for all, and it is impossible to find one style of learning that is the best fit for everyone. We are moving further from the notion of one style of teaching for all learning through the creation and use of personal learning plans (Pratt, 2015). Several definitions of pedagogical discourse in mathematics classrooms exist but consistently include discussion, justification, argumentation, and negotiation as the vital aspects at the centre of mathematics pedagogy to improve students' conceptual understanding in the factual sense (Cobb & McClain, 2005; Donovan & Bransford, 2005; NCTM, 2014; Shortino-Buck, 2017; Yackel & Cobb, 1996). The importance of recognizing children as creators of their own learning and encouraging them to express that learning both through clarifying their understanding and communicating it to others. (Whitin & Whitin, 2000). Pedagogical discourse in mathematics classrooms is an effective method for facilitating a child's conceptual understanding and acquisition of mathematical knowledge that allows for growth in achievement across students (Stylianou & Silver, 2004). It is also related to how knowledge is validated and organized accessing a role in constructing new knowledge. While participating in mathematical discourse, students reason through their current thinking with input from peers and ask to clarify their own, as well as peer understanding of the mathematical discourse.

Pedagogical discourse in mathematics classrooms clears up student misconceptions, improves students' ability to reason logically, gives students more opportunities to participate in their learning, and provides socially grounded motivation to learn (Chapin, O'Connor, & Anderson, 2009). As a social activity, pedagogical discourse in the mathematics classroom is dependent on the language acquisition of the student participating in the discourse and the scaffolding that the teacher provides to bridge language gaps. While pedagogical discourse in mathematics classrooms encompasses more linguistic patterns, it relies heavily on the ability of the student to explain or show his/her thinking to other participants. Johnstone (2002) claimed that discourse is communication using language even though, not all communications use formal language. Communication uses symbols, and physical gestures, visually as well as orally, and with written language.

Educators are constantly looking for changes in society and technology to consider multiple ways students can learn well. This is an exciting time to be in education, but also an unsettling time with so many changes in the pipeline. In the process of different methodological studies, (Deaconu & Pfaff, 2017) focused on their studies of discursive space, relations between discourse in rehearsal and classroom spaces found discourse in both rehearsal and classroom settings to better characterize the nature and mechanisms of change across these settings and the role that rehearsal plays (p. 70). It was found that not only were both rehearsal and classroom spaces valuable in their own right to changes in teacher practice, but the relation of rehearsal and classroom enactments also initiated change. Classroom discourse enables students to discuss mathematical ideas and concepts with their teacher and peers and has been shown to increase student learning (Mitchell, 2014; Pratt, 2015). Any discussion of the challenges to implementing reform must also acknowledge the complex nature of the classroom that hampers its ability to respond quickly to all influences. Moreover, the interconnections are manifold. Substantive changes in a teacher's practice require simultaneous changes in a variety of areas, including teacher-student interactions, curricular activities, assessment practices and instruments, children's attitudes toward mathematics, and teacher expectations for students (Mitchell & Knuth, 2003). Through classroom interactions, the differences between teachers' and students' attitudes and perceptions are mitigated.

Suh, Tappert, Gibson, and Stevens (2008), in their research work, state that mathematics can be thought of as a language that must be meaningful if students are to communicate mathematically and apply mathematics productively (p. 79). It is important, therefore, to provide opportunities for them to talk about mathematics. Talking about their thinking clarifies students' ideas and gives the teacher valuable information from which to make instructional decisions. Student learning achievement and learning environment are kept at the core and teacher support is surrounded by the outer atmosphere. Herbel-Eisenmann, Choppin, Wagner, and Pimm (2012) focused their study on equitable discourse practices in mathematics classrooms, stating diverse perspectives for stakeholders on opportunities and challenges for reforming mathematics classroom discourse. Equitable classroom discourse is about who is participating and who is not. Who has access to discourse and who does not? Who is capable and who is not? It is to facilitate the learner by meditating on all these things. This means the classroom discourse is not only limited to the circle of a self-participating group of students but the teachers are responsible for giving equal participation opportunities to all the pupils in the plenary discussion and the teacher should apply 'focus on the student', 'multimodality', 'policy', 'classroom practice', and 'approaches to discourse'. Equal participation in logical and constructive interactions is the opportunity for learning to a pupil which the teacher accomplishes in the classroom. Furthermore, Saengpun (2013) talks about univocal discourse and dialogic discourse.

Forms of Classroom Discourse

Different firms of classroom discourse are used in teaching and learning mathematics. Some of them are oral discourse, written discourse, univocal discourse, and dialogic discourse.

Oral Discourse

Oral discourse in mathematics instruction refers to the verbal exchange of ideas. Both teachers and students use verbal speech when doing mathematical tasks. Teachers can actively engage students in mathematical thinking by promoting discourse (Pontecorvo, 1997). In discourse-rich math classes, students explain and discuss the strategies and procedures they use to solve mathematical problems, combining their everyday language with specific math vocabulary (Hauge & Barwell, 2017). Through discourse, teachers can better understand the mathematical needs of the classroom—what students know, the misconceptions they have, and how these may evolve (Ouyang, Tang, Cheng, & Chen, 2023). Through oral discourse, mathematics teachers easily explain various rules, formulas, and methods applicable to specific problem-solving (Grimwood, 2008). Oral discourse is used mixed with written discourse to understand mathematical terms, symbols, representations, and connections between variables (Krussel, Edwards, & Springer, 2004). Similarly, students use oral discourse to present their state of understanding, and misconceptions, in the form of questions and answers. Oral discourse plays an important role in classroom activities of teaching and learning.

Written Discourse

Written discourse is an essential part of teaching and learning in mathematics. It is a way of sharing ideas and clarifying understanding. Through written discourse, ideas become the object of reflection, refinement, discussion, and revision (NCTM, 2000). Every mathematics learning event is also a literacy event, and every literacy event in the mathematics classroom is a mathematics learning event (Draper & Siebert, 2004). In mathematics courses, students are asked to explain, justify answers, and provide reasoning for many problems in their everyday tasks and problem-solving situations. Students need to use written discourse not only to communicate their understanding of mathematics but also to deepen their understanding of the mathematical concepts being taught. (Baxter, Woodward, & Olson, 2005; Pugalee, 2004). Written discourse allows students to express thoughts, feelings, and experiences that can develop their critical thinking, sound reasoning, and problem-solving skills. Mathematical learning includes all written works, diagrams, pictures, symbols, and figures, which cannot be expressed verbally without written forms (O'Halloran, 2008). Teachers should model appropriate writing, provide feedback, and provide opportunities to revise writing to guide students toward expectations in written communication. It is important to avoid a premature rush to apply formal mathematical language (NCTM, 2000). Writing provides space for students to explore and reflect on their own ideas. Being able to express thoughts, feelings, and experiences can lead to the development of higher cognitive functions, including critical thinking, sound reasoning, and problem-solving (O'Halloran, 2008). Writing is one of the ways to remember formulas, rules, equations, and problem-solving methods. Therefore, the teaching and learning of mathematics are full of written discourse, neither the teacher can teach nor the students can learn.

Univocal Discourse

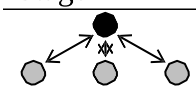
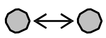
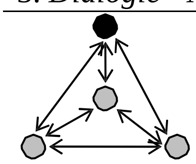
Univocal discourse is spoken or written forms used by the students to communicate their understanding of the problem situation and their problem-solving strategies with the teachers and their classmates. Univocal discourse is the communication in which the listener receives the ‘exact’ message that the speaker intends for the listener to receive (Knuth & Peressini, 2001). Once the speaker's intended meaning is conveyed, the episode of univocal communication is considered to be successfully finished. Univocal discourse is the one-way speech method in which the teacher speaks and students listen and the teacher feels proud of their delivery system of what they intended.

Dialogic Discourse

Dialogic discourse is a spoken or written form used by the students and teacher in communicating, responding, and exchanging ideas. The methods of problem-solutions in which the teacher has a crucial role in this discourse by re-voicing and expanding the students’ univocal discourse to ensure the collective understanding of the contents and strategies for solving mathematics problems (Knuth & Peressini, 2001). Dialogic discourse, in contrast, is characterized by give-and-take communication in which the listener initially receives the ‘exact’ message delivered by the teacher. At this point, univocal discourse ends, and dialogic discourse just begins. Dialogic discourse generates meaning by using dialogue as a ‘thinking device’ (Lotman 1988, p. 36). Dialogic discourse is an essential tool in the classroom teaching of mathematics. Harlow and Otero (2004) present patterns of discourse that exist and are mostly exercised in classroom teaching.

Black circles represent teachers and grey circles represent students.

Table 1. *Patterns of Classroom Discourse*

Stage	Participants	Statements
 1. *Univocal – Descriptive*	Teacher – Students	*Elicitation* (teacher) *I saw*
 2. *Univocal - Model*	Teacher – one student	*I think* (students) *You think – probing* (teacher)
 3. *Dialogic - Model*	Student – Student	*I think* (students)
 4. *Dialogic - Model Discussion*	Teacher – Student And Student – student	*You think* *probing,* *You think* *clarifying,* *Evaluation, I think*

Source: Harlow & Otero (2004)

Table 1 shows the four stages of classroom discourse. The first stage of discourse is the univocal-descriptive stage, which is considered by the teacher to provoke knowledge from the students. This narrative dialogue provides an exchange of knowledge between teachers and students. The second stage, univocal – involves model identification, beliefs or theories, and explanatory statements. The third stage of the model is dialogic–model establishment, which involves the frequent exchange of knowledge between two students. The fourth and final stage of the intricacy stage is dialogue – in this stage of model discussion, other students enter the conversation and clarify and support previously established viewpoints.

Power of Discourse in Mathematics

Discourse in mathematics is the powerful discourse among all the subjects in classroom teaching at school level students as it underpins various subjects like physics, economics, accounting, and statistics. Communicating their thinking in mathematics is challenging for school children. Mathematics teaching is not only verbal discourse but also written discourse with various symbols, logical operators, functions, and mathematical operators. In designing this research, it is important to differentiate between reading textbooks and reading word problems, two different genres in mathematical written discourse (Moschkovich, 2010). When working with children learning to read in their mother tongue or second language, it will be important to distinguish between competent readers in the first language and children who do not know it. Since language seems to be so closely associated with vocabulary, we should develop principles and research-based best practices for supporting students in learning to use vocabulary in mathematics classrooms. This reflects that the teaching language or discourse language also plays a vital role in learning capacity building for pupils as languages are ways of transforming information and meaning. Mathematics is a language that is developed using symbols. To study mathematics, it is necessary to understand the language in what way the mathematics read and write (Kharde, 2016). Most teachers use traditional mathematics teaching in the classroom rather than implementing new approaches.

Therefore, the teacher’s professional development training and counseling to motivate students are effective. Thus, teachers’ professional training is effective in changing teachers' behaviour toward productive classroom discourse (Kiemer et al., 2015). Communication frequently involves the ability to clearly articulate oneself through all media of communication— oral, written, nonverbal, and digital—as well as the skills necessary to be an active and respectful listener to diverse audiences. The collaboration includes similar dimensions as communication but also includes important individual contributions, such as flexibility, willingness to participate, and recognition of the group and individual efforts and success (Kereluik, Mishra, Fahnoe, & Terry, 2013). Communication and collaboration are essential for classroom teaching-learning activities.

Esmonde (2009) describes the mathematics teaching complexity as although discourse analysis is becoming widely used in mathematics education research but argues that it is still common for researchers to focus on the content of the mathematical talk, without considering the interactional context in which talk occurs (p. 24). In mathematics, classrooms are characterized by hybridity, in which students must choose between competing discourse practices around explaining, their choices position students as certain kinds of people within the classroom. According to Gee (2000), the characteristics of the talk will not be able to address some critical questions related to mathematical discourse and learning: what social actions do students perform through allegiance to or breaches of socio-mathematical norms? How do these social actions support their identities as mathematics learners, and how does their talk support mathematics learning? This analysis, helped me to understand mathematical discourse is not just talking, it carries meaning and is intended for the specific understanding of the teacher and transferring process to learners.

There is a long history of studies of language and mathematics. Ormell and Pimm (1989) suggest that there are three levels of relationship: mathematics and language, the mathematics of language or conversely the language of mathematics, and mathematics as a language. Zevenbergen (2000) discusses mathematics as a register with its specialized vocabulary, semantic structure, and lexical density. She maintains that language is a form of cultural capital, and suggests that students must learn to 'crack the code' of the mathematics classroom, a task which is less accessible to students from working-class backgrounds than to students from middle-class backgrounds. Mathematical language is often vague or ill-defined, and symbols are used imprecisely (Thornton & Reynolds, 2006) but symbolically well illustrated. I also support this statement because mathematics is a combination of languages, symbols, and operators where an absence of one makes an imbalance in mathematics. Furthermore, Thornton and Reynolds (2006) describe mathematics as fun stating in their language that the mathematics classroom is for students to regard mathematics as an art that belongs to them, a means of regarding and interpreting the world, a tool for manipulating their understandings, and a language with which they can share their understandings to have fun and to feel in control (p. 6). Of course, mathematics has to be fun in teaching-learning activities but I argue with my experience of more than one and a half-decade, it is not the same for all learners as the multicultural classroom is to be quite diverse in the cognition and understanding levels.

Pastoor (2008) describes the mathematical phenomenon as a different subjectivity as the mathematical discourses are mostly going in the classroom but merely outside of the everyday activities of the classroom (P. 37). A fundamental condition for sharing and developing classroom knowledge in and through discourse is achieving a certain mutuality of perspectives, that is, inter-subjectivity, between the participants of the discourse. Especially in classrooms where pupils have diverse linguistic and cultural backgrounds, pupils' involvement in classroom discourse stimulates by making explicit the interpretive premises for the subject matter content under discussion (Moschkovich, 2010; Ormell & Pimm, 1989). The confusion many pupils experienced in the mathematics lessons, as a result of ambiguous mathematical terms and difficulties with the mathematization of unfamiliar everyday situations, proves the importance of establishing shared premises for problem-solving (Tall & Razali, 1993). Discourse practices involve not only language but also perspectives and conceptual knowledge. It is not disembodied talk; it is embedded in practices (Thuy, 2020). Words, utterances, or texts have different meanings, functions, and goals depending on the practices in which they are embedded (Moschkovich, 2007). Discourses occur in the context of practices tied to communities.

I view discourse practices as dialectical, cognitive, and social perspectives. On the one hand, mathematical discourse practices are social, cultural, and discursive because they arise from communities and mark membership in discourse communities. On the other hand, they are also cognitive, because they involve thinking, signs, tools, and meanings. Instructional practices for supporting the mathematical learning of their pupils focus mainly on the issue of applying language as a means of basic oral communication. This finding is not surprising, considering, as argued elsewhere (Xenofontos, 2015), the same teachers hold a strong belief that linguistic barriers are the main source of the many difficulties that pupils encounter in mathematics classrooms. The possible relevance of mathematics seems to be hidden in the school mathematics tradition. As a consequence, it might become difficult for some students to see that mathematics could play a significant role in their future. If meaning for students somehow is related to their foreground, then instrumentalism could become a strict implication of the fact that mathematics appears as a clean and isolated subject (Alro, Skovsmose, & Duenas, 2007). To fully understand how improving mathematical discourse can improve students’ mathematical ability, we must first discuss what constitutes mathematical proficiency. In this context, Foy (2013) suggests that mathematical proficiency consists of conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition.

Furthermore, Foy (2013) interprets a common theme in new mathematical research as the idea that teachers should be steering away from traditional methods of teaching, which is for procedural proficiency most of the time. Classrooms that incorporate rich mathematical discourse show the potential to improve conceptual understanding among students. There are many ways teachers can improve the discourse that goes on in their classrooms and shift towards better conceptual understanding. Teachers need to know when to tell and when to allow students to discover mathematical ideas. Traditional practices consist of a lot of teachers telling and not enough students' discovering. However, Kokkonen (2009) analyses the communication used by a teacher or a peer tutor affects the student's learning and how meaningful or unpleasant the learning situation is due to the discourse occurring between the teacher and the students. Moreover, the styles of communication are being used in different settings. The conversations between teachers and students are not only interesting and spell-bounding but also stern sometimes because they are intended for the learning of students.

Mathematics teaching has different functions. In the view of Hill, Rowan, and Ball (2005), mathematics learning contributes to and participates with confidence in society. The teaching and learning of mathematics can enable the learner to develop an awareness of the diverse historical, cultural, and social practices of mathematics. It recognizes that mathematics is a creative part of human activity; and develops deep conceptual understandings to make sense of mathematics. It acquires the specific knowledge and skills necessary for the application of mathematics to physical, social, and mathematical problems of related subject matter, and further study in mathematics (Panthi & Belbase, 2017).

Effective discourse happens when students articulate their ideas and seriously consider their peers' mathematical perspectives as a way to construct mathematical understandings. Encouraging students to construct their mathematical understanding through discourse is an effective way to teach mathematics, especially since the role of the teacher has been transformed from being a transformation of knowledge to one who presents worthwhile and engaging mathematical tasks.

Discourse as a Pedagogical Approach in Mathematics

Instead of teaching kids, love the math they hate,

Let us make math that, kids will love to learn.

- NCERT (1971)

The nature of mathematics teaching significantly affects the nature and outcomes of student learning. This highlights the huge responsibility of teachers toward their students' mathematical well-being. Anthony and Walshaw (2007) suggested ten key principles as a starting point for discussing change, innovation, and reform. Major innovation and real improvement require aligning the efforts of teachers, principals, teacher educators, researchers, parents, specialist support services, school boards, policymakers, and the students themselves. For this, schools, communities, and nations need to ensure that their teachers have the knowledge, skills, resources, and incentives to provide students with effective learning opportunities (Hill, Rowan, & Ball, 2005). Along with believing that pedagogical discourse in mathematics classrooms is important to mathematical achievement, teachers need to understand the pedagogy of mathematical discourse. Smith and Stein (2011) developed five practices to be used in classrooms that implement pedagogical discourse in mathematics classrooms such as *anticipating* - student responses before the lesson; *monitoring* - students' work on and engagement with the task; *selecting*- particular students to present their mathematical work; *sequencing*- students' responses in a specific order for discussion; and *connecting*- different students' responses and connecting the responses to key mathematical logic.

A teacher's pedagogical skills are central to discourse in mathematics classrooms because skilled questioning leads to productive discourse. By modeling a high cognitive level of questioning, teachers show students how to interact with each other with a rich discussion that leads to conceptual understanding (Akkuss & Hand, 2010; Shortino-Buck, 2017). So, management is one of the major elements of effective teaching and learning and a contributing factor to efficiency. The better the management is in the classroom, it contributes to students' stay at school and the higher their achievement. It is, because, real-life schooling needs to be dependent on the management of the classroom (Dhakal, 2014). The teacher can engage students with productive and active participants in their mathematical learning with the addition of interest in the classroom discourse.

Mathematics Learning Through Discourse

Effective pedagogical discourse in mathematics classrooms greatly affects the learning motives of the students. Effective discourse and cooperative sharing increase the understanding level of students clarify the mathematical concepts and problem-solving skills, as well as affect their use of vocabulary and written explanations (Hillen, 2006). Effective classroom discourse and cooperative learning result in positive changes in students' attitudes about their ability to explain and understand mathematics. Moschkovich (2007) suggested that classroom discourse is thought of as cognitive, social, and cultural because classroom discourse does not only involve the use of language but also the use and development of conceptual knowledge with embedded cultures. Theorists and researchers suggest that the pedagogy of mathematics discourse involves the active participation of students collaboratively constructing meaning by equally controlling the conversation and sharing in developing a conclusion based on the exchange of thinking, innovating and motivating colleagues, and critiquing the performance of each other in the classroom (Alexander, 2008; Burbules, 1993; Freire, 1993; Reznitskaya & Gregory, 2013; Shortino-Buck, 2017).

It has been theorized that all the learning takes place in a community and the vigorous progress for communal participation and understanding is the language with speech (Lave & Wenger, 1991). Based on community learning, classroom discussion is the key to a student's conceptual and cognitive understanding. The bonding of student contribution to class discussion, students' active participation, and conceptual understanding are not alone. Teachers must explicitly communicate participation procedures, and establish a classroom culture in which students are encouraged to participate even when they do not fully understand at first continuity in classroom participation enables them to understand gradually and this regular tradition creates essentiality in the tendency of learning. (Walshaw & Anthony, 2008). The most important part of teacher conversation to increase student participation and accession is making clear to students those contributions, whether correct or not, enhance the conceptual understanding of the student contributing and his or her crony students.

Battista (1993) and Hungerford (1994) studied the barriers to effective pedagogical discourse in mathematics classrooms and concluded that one of the barriers that arise with implementing pedagogical discourse in mathematics classrooms in high school is the insufficiency of teacher training in mathematical discourse, concepts, and the unfamiliarity with the pedagogy that supports classroom discourse in mathematics teaching. With underprivileged teachers preparing to teach conceptual understanding of mathematics, accomplishing effective discourse in mathematics has been challenging and often under-sustainable (Ball, 1991; Shortino-Buck, 2017). Self-motivated, well-skilled, and well-trained teachers with updated technological access can enrich the pedagogical discourse in mathematics classrooms and clarify mathematical concepts.

Diverse Social Scenario of Nepal

Nepal has been a multicultural, multilingual, multi-ethnic, and multi-religious country (Acharya, 2015; MoE, 2016) since the ancient period which was then indicated by the great king Prithvi Narayan Shah – “Nēpāla cāra jāta - chattīsa varṇakō phulabārī hō”[2] and now our national anthem is enough to reflect the cultural pluralism – “Sayauṁ thumgā phūlakā hāmī ē'utai mālā Nēpālī”[3]. The multicultural

2 This means Nepal is a common flower garden of four castes and thirty-six sub-castes.

3 The first line of Nepal’s national anthem which means “We are hundreds of flowers, the one garland – Nepali”

society of Nepal is hierarchical and divided along the lines of caste, ethnicity, language, and its schooling system, including curriculum and pedagogy (Khanal, 2017). Therefore, our school education and pedagogic activities are of course multicultural. Nepal is a country of diversity in terms of geography, languages, caste, ethnicity, religion, and culture. About 29.19 million people (Census Nepal, 2022; CBS, 2022) in our country are divided into 142 castes/ ethnic groups speaking more than 124 languages (CBS, 2022). Thus, Nepalese schools are filled with students from different social, cultural, ethnic, and cognitive backgrounds. In this situation, teaching and learning become challenging tasks (Acharya, 2017). Our schools and classrooms are the great arenas of the explosion and preservation of these multicultural traditions and playgrounds of intermission of cross cultures. The cultural heritage of Nepal has evolved over the centuries and the culture of Nepal is rich and unique. This multi-dimensional heritage encompasses the diversities of ethnic, tribal, and social groups and it manifests in music and dance, art and craft, folklore and folktales, language and literature, philosophy and religion, festival and celebration, food and drinks, cognition, and schema (Acharya, 2015; Bhattarai, 2004; Bista, 1991). Our teaching-learning activities are hardly addressing this cultural pluralism across subjects and curricula.

Although mathematics is taken as a culture-free subject underlying the universal language, it is with us and we are with it in our everyday activities. Therefore, our culture is highly bonded with mathematical languages, calculations, logical thinking, and problem-solving. Mathematics plays a vital role in the advancement of culture and civilization (Acharya, 2016). Mathematics is an intellectual activity, arguably one of the most sophisticated ever produced by human civilization (Bhattarai, 2004). Mathematics directly deals with human life and cultures. It is believed that the development of mathematics and the development of civilization go together and are created to fulfill human needs. Mathematical concepts based on cultural perspectives allow students not only to reflect on and appreciate their own culture but also the culture and traditions of others (D’Entrimont, 2015). The involvement of members of the community is an essential part of the integration of cultural components into mathematical activities.

Cultural Pluralism as an Identity of Nepal

In terms of culture, Nepal is the richest country in the world and a mosaic of many different cultures, languages, and religions (Khanal, 2017). The National Population Census of 2022 has recorded 142 castes/ethnic groups in Nepal. Besides, there are 124 different languages spoken as the mother tongue. Similarly, there are different ten religious categories reported in the National Census of 2022 (CBS, 2022). This kind of cultural and linguistic diversity in the country is both a challenge and an opportunity. As Nepal is a multi-lingual, multi-ethnic, and multi-religious country, the education system of Nepal is experiencing problems with bilingual and multilingual children and children with cultural differences. The culturally responsive education system in Nepal is necessary not only to increase access to education but also to build the foundation of a culturally- rich society (Regmi, 2017). As the school is conceived as a social unit, culture in the schools could stimulate inclusive practice in the whole society by accepting and celebrating diversity, individuality, and cognitive differences. Keeping consideration of the prime role of the school community in developing a multicultural society, this study is focused on assessing the situation of inclusive culture in community schools.

This study would contribute to developing strategies to promote a culture of inclusion in the school community that ultimately helps to establish an inclusive and cohesive society. There is no single and universally accepted definition of multicultural education because it is viewed from a different social and contextual lens. Multicultural education is basically an ideological shift of international educational discourse that underpins multiple disciplines (Acharya, 2012; Regmi, 2017). Although multicultural education has been conceptualized in many different ways, the idea of inclusion within the educational framework is frequently attached to the concepts of mainstreaming, diversity management, learning environments, school cultures, inclusive schools, and equal educational opportunities (Westwood, 2013). Cambridge International Dictionary of English (2018, June 30) defines culture as “the way of life, especially general customs, and beliefs of a particular group of people at a particular time and place”. Pokharel and Paudel (2014) claim that culture is the totality of socially transmitted behaviour, patterns, arts, beliefs, institutions, and all other products of human work and thoughts as well as the total of inherited ideas, beliefs, values, and knowledge which constitute the shared bases of social actions.

Culture is related to the development of the mentality, which people follow during their life in their activities. It is also known as the following of a particular kind of system or pattern in the course of lifetime activities whatever they may be acculturing or enculturing. Therefore, we have a religious culture, educational culture, musical culture, social culture, past culture, modern culture, and schooling culture. To this end, I can claim that the quality of education also results in the culture of the existing educational system and accessibility. It is agreed that both the teachers’ and students’ cultures influence classroom activities.

Social and Cultural Diversification

Another dimension of school education is to accept and respond to diversity. The concept of diversity refers to the acceptance and respect of individual differences with the belief that each individual has a unique character. Individual difference belongs to different dimensions of caste, ethnicity, gender, sexual orientation, socio-economic status, age, physical disabilities, religious beliefs, and political ideology. Therefore, diversity management is the exploration of these differences in a safe, positive, and nurturing environment (Regmi, 2017). Addressing diversity in education means celebrating diversity and supporting the participation of all students who face any type of learning or behavioural challenges in terms of socioeconomic status, ethnic origin, cultural and religious context, linguistic heritage, gender, and sexual preference. (Topping & Maloney, 2005). Messiou (2012) perceived an inclusive education system as a subset of an inclusive society, in which diversity among people is acknowledged, accepted, and valued. It emphasized responding to all pupils as individuals by reconsidering the curriculum, educational structures, and other provisions (Sebba & Ainscow, 1996). UNESCO (2005) has viewed cultural education as a dynamic approach that responds to pupils' diversities and sees individual differences not as problems, but as opportunities for enriching learning.

Pottas (2005), further added that it is a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures, and communities. It involves the changes in modifications in content, approaches, structures, and strategies within a common vision that covers all children of the appropriate age range. Cultural education is concerned with providing appropriate responses to the broad spectrum of learning needs in education. As an approach, it looks into how to transform the education system and learning environment to respond to the diversity of learners to enable teachers and learners both to feel comfortable with diversity (Sands, Kozleski, & French, 2000). Cultural diversity is an important factor attached to the education system that a teacher should always keep in mind while performing classroom activities.

Mathematical Discourse within Cultural Diversity

As a mathematics teacher, I have one and a half decades-long experience with the existence of culture and learning diversities in mathematics classrooms. This cultural and learning diversity is one of the precious characteristics of Nepali society as well as a challenging factor in handling classroom teaching. Teaching mathematics to a group of students with the same mathematical abilities, the same learning styles, and the same cultural backgrounds would probably be less challenging. However, this is not the reality in the classroom. Students in the same class have various lived experiences, cultural backgrounds, and learning styles (Scott, 2001). The cultural realities of each school jurisdiction characterize the needs of its students which in turn determines the curriculum and teaching styles to meet the needs of the cultural reality within it. These cultural differences must be taken into consideration if learning, in any subject, is to take place.

Culture is the beliefs, values, attitudes, customs, social relationships, art and literature, languages, and indigenous activities that define and distinguish an ethnic group of people (Abidi, 1996; Banks, 2006; Gay, 2004). Many teachers of subjects such as mathematics, chemistry, physics, and biology are under the impression that mathematics is a non-cultural subject. It is clear however that mathematics is not a culture-free discipline. It can be said that all cultures are rich in artifacts that exhibit mathematical concepts (Acharya, 2015a; D'Entremont, 2015). Schools and classrooms are the integration of different cultural groups because the students of various cultural groups gather from their different learning capabilities, languages, religions, and beliefs. A mathematics teacher should understand such a situation and employ teaching strategies to address culturally diversified students.

Discourse of Ethno-mathematics

Ethno-mathematics is a term used in connection and mutual interaction that exists between mathematical culture and political culture (D'Ambrosio, 2001). The 'ethno' part of ethnomathematics consists of the language and vocabulary, behavioural norms, and symbols of certain groups (Katsap & Silverman, 2016). It is dependent on the cultures of particular groups and is influenced by their historical development and their accumulated experience. The mathematics part refers to the opinions, understanding, explanation, and execution of actions like coding, measurement, sorting, organization, deduction, and modeling. Amit and Quoder (2017) claim that ethnomathematics is a learning opinion of educated people, claiming that, though mathematical opinions are present in all cultures, they differ from society to society in how they manifest in their cultural content. Anderson (1998) also connects ethnomathematics with mathematical opinions, which can be expressed in different ways, in writing, acts, or speech. The essence of the ethnomathematics program is to acknowledge that there are different ways of doing mathematics by considering the appropriation of the academic mathematical knowledge developed by different sectors of society as well as by considering different modes in which different cultures negotiate their mathematical ideas and practices (Acharya, 2015a, 2017; D'Ambrosio, 2001).

Furthermore, Orey and Rosa (2007) argue that ethnomathematics is a paradigm that diverse cultures use or work within and involves unique interactions between their language, culture, and environment. Therefore, ethnomathematics is the mathematics connecting the existing cultures, languages, and activities within sociocultural rooting.

From this, I understand that classroom mathematics is deeply rooted in the cultures, identities, and ideologies of the individual. Mathematics is identified in cultural activities in traditional and non-traditional societies (Rosa & Orey, 2013). This means that ethnomathematics refers to mathematical concepts embedded in cultural practices and recognizes that all cultures and all people develop unique methods and sophisticated explications to understand and transform their realities (Orey, 2000). Ethno-mathematics studies the cultural aspects of mathematics. It presents mathematical concepts of classroom teaching and these concepts are related to students' cultures and daily experiences enhancing their abilities. Ethno-mathematical approaches are intended to make school mathematics more relevant and meaningful for students and to promote the overall quality of their education (Rosa & Orey, 2011). In this context, the implementation of an ethnomathematics perspective in school mathematics teaching helps to develop students' intellectual, social, emotional, and political learning by utilizing their own unique culture. It also improves their knowledge, skills, and attitudes.

Ethno-mathematics in classroom teaching is the process of understanding individual students by their learning abilities, cognitive domain, cultural influences, beliefs, and thoughts and employing the appropriate teaching strategy and method from which each student in the classroom gets the maximum achievement (Belbase, Luitel, & Taylor, 2008). The situation of classroom teaching and learning activity differs in different approaches, which are determined by various factors such as culture, social phenomena, and learning strategies adopted by teachers as well as students. Social and cultural factors shape the lifestyle and everyday activities of humans and categorize them in many forms and norms. These factors also contribute to making human beings interactive within the social system.

Education is the subsystem of the larger social system, supposed to influence the education cycle of both the students and teachers in the process of knowledge transfer in society (Dhakal, 2014). Classroom teaching is the connection between mathematical content and the culture of the learners, its curricular relevance goes beyond designing study programs that fit the individual interests and customs of the culture that studies them. Such a focus might limit the teaching-learning activities only to mathematics that the students find relevant or interesting, and that they see as connected to their cultural role or vocation (D'Ambrosio, 2000). Integrating mathematical principles and methods from the learners' culture into the formal academic curriculum can help them to draw their own mathematical experience to better understand and apply the mathematical principles. Drawing on the learners' general mathematical knowledge can help make conventional mathematics more accessible and give learners a greater appreciation of its practical value (Orey, 2000).

Teaching mathematics in combination with traditional cultural elements and values helps students understand various mathematical ideas. Including elements from students' everyday lives in their mathematics education encourages more meaningful learning and can produce more effective achievements. The connection of daily activities encrypted with traditional cultures increases students' motivation to learn (Amit & Quoder, 2017). Davison (1989) also noted that harnessing cultural values as a means of conveying mathematical content helps to emphasize the relevance of mathematics to the learners' lives which in turn makes the lesson more interesting and enjoyable. Everyday applications also spark students' curiosity and motivation to work towards finding a solution to the problem (D'Ambrosio, 1993). Other studies have also shown that linking household culture to mathematics boosts the student's self-esteem and motivation to learn.

Empirical Review of Discourse in Mathematics Education

An empirical review of the literature on discourse in mathematics education helped me identify research gaps in mathematics classroom discourse. I conducted an empirical review of the literature within the thematic areas of cultural relevance in mathematics teaching, discourse in the mathematics classroom, social justice in the mathematics classroom, discourse for student engagement, discourse for identity construction, discourse for meaningful mathematics learning, teachers' role in discourse and students' role in discourse.

Cultural Relevance of Discourse in Mathematics Teaching

In exploring cultural relevance in mathematics teaching; Acharya et al. (2021), concluded that teaching mathematics in the mother tongue, culturally contextualizing mathematics, and incorporating local knowledge into everyday mathematics learning is appropriate. Therefore, the mathematics curriculum should be culturally appropriate for the students and integrate the content so that the students can experience in the mathematics classroom what they see in their families and everyday life. In a similar scenario, Acharya (2012) concluded that students experience problems in learning mathematics because of the difference between their home language and the language of instruction. Students have suffered because of colonial and developed mathematical concerns. The centrally prepared curriculum only takes cultural diversity into account, so teachers face professional challenges. In multicultural settings, teachers were less trained in the knowledge of pedagogy appropriate to such a classroom environment.

Furthermore, Acharya (2013) concluded that there are communication problems between teachers and students in mathematics classrooms where one of the challenges in teaching mathematics. Teaching learning activities among teachers and students have been less effective in different linguistic backgrounds.

Contextualization of mathematics teaching-learning activities was another challenge. It has been found that teachers are incompetent because they have not been trained to teach mathematics in a multicultural environment. Moreover, the pedagogy used by them was found to be mono-cultural and monolingual using the Nepali language. The classroom pedagogies and curricular integration were found to be influenced by the dominant ideologies of Western culture rather than embodying the students' own culture. Culturally designed mathematics education draws on students' knowledge and the cultural and linguistic resources they bring to the classroom. This approach places the teaching and learning of mathematics within the context of students' sociocultural experiences. It provides opportunities for students to relate math learning to their cultural context such as background knowledge, mother tongue, etc., and helps them develop their cultural identity and self-image as competent math learners (De Abreu, 2020). This is important because many students find math difficult and math problems can persist throughout their education. Different researchers (Herzig & Steinthorsdottir, 2020; Onwu & Kyle, 2011) have also shown that culturally engaging approaches to mathematics encourage students to use higher-order thinking skills such as analysis, reasoning, and evaluation.

Regarding discourse in a mathematics classroom in Nepal, Nakawa (2013) claimed that especially at pre-primary levels teachers display teacher-centered classroom discourse. The classroom was teacher-dominated and the classroom discussions were limited to only asking “What is the answer of…...?” The teachers and students replied just numerical values like ‘15’. The author also claimed that Nepal is a garden of a multicultural society and the mathematics curriculum is not enough to address the diversity. The ultimate goal of mathematics teaching was not achieved at the classroom level. Almost all the lessons were teacher-centered and far from a child-friendly or child-centered approach. This study found that the teachers’ activity was mostly oriented toward the examination and passing the student from one grade to another but not a better understanding of the mathematical concepts. Similarly, Pokharel and Poudel (2014) found that there were four major reforms: teachers’ practices, examination system, students’ engagement, agreeable situation, and textbook and curriculum. These four stages of addressing critical thinking in a mathematics classroom in Nepal were based on socio-cultural settings, leading to the daily and future usefulness of mathematics.

Along the same line, Dhakal (2014) concluded that innovative and creative activities such as collaboration, the rationality of collaboration, discussion, and dialogue were not well reflected in classroom discourse. This study reflected on classroom discourses on various topics by focusing on intensive classroom activities by school teachers and students to give a reality of what is happening in Nepali classrooms. It was a critical analysis of Nepali educational discourse from a cultural perspective. It has shown that teaching and learning qualities are inherent and essential to the articulation of teachers' and students' cultural perspectives in classroom discourse. Cultural perceptions of teaching and learning activities by teachers and students were very strongly reflected in educational transactions. Collaboration and cooperative rationality in guiding discourse make teaching and learning activities imaginative, innovative, interactive, and creative through specific activities such as discussion, dialogue, interaction, and interpretation (Dhakal, 2014).

Schools and their environments, community and educational policy, student learning activities and outcomes, and effective classroom discourse in cultural contexts are integral elements of mathematics education (Giri, 2021). Learning in children's mother tongue is more effective and a key factor in making students actively participate in the classroom. The role of teachers and parents is fruitful in motivating and encouraging students to engage in teaching and learning activities in multicultural classrooms (Hessari & Hill, 2017). Student-centered educational activities ensure the promotion of mathematical achievement in academic learning activities and students also rely on their ethnic beliefs and cultural values.

Discourse in Mathematics Classroom for Social Justice

Advocating for social justice in the mathematics classroom discourse, Panthi, Luitel, and Belbase (2018) focused on equality, equity, fairness, social process, and caring for students. Equality as a dimension of social justice is related to treating all students equally. Teachers should manage the classroom environment by asking questions equally to all students in the classroom so that students feel equal to each other. Teachers may face challenges to transform students' thoughts about themselves as a member of a learning community (Belbase, 2006; Luitel, 2009). Teachers' perception of equality is to behave equally with all students, not to deviate from them, to make them enjoy freedom, and to create an environment of equal justice. Teachers' view about teaching according to the capacity or level of students has a great pedagogical significance (Luitel et al., 2012). Some of the teachers' views about uniformity in the classroom as a part of equality contradict the view that weak and marginalized students should be given more focus to help them learn mathematics.

Teachers' views about equality in terms of students having a similar position in their classroom, in terms of roles, responsibilities, and sharing of resources imply social justice. Their perception of social justice through mixed grouping and sharing their culture in a respectful environment is an important aspect of equity. The perception of fairness connects to teaching without bias, providing students with an equal chance to learn, and transparent classroom activities promote social justice in the multicultural mathematics classroom (Belbase, 2006, 2013). The perception of caring is linked with caring for marginalized students in the classroom, helping them in learning by providing them extra time for coaching or guiding and improving their performance. It is claimed that the morality of justice and morality of care are an integral part of social justice. Hence, both policy and pedagogical implications connecting teachers' perception of social justice in the mathematics classroom to macro elements of social justice at social, economic, cultural, and political factors and microelements of school and teachers' awareness and actions to promote equality, equity, fairness, social processing, and caring students and their needs. The consultation of their parents, grandparents, and teachers has a great impact on students studying mathematics.

The verbal behaviour of elders like friends, teachers, parents, and grandparents has a vital role in creating anxiety or motivation in mathematics learning (Budhathoki et al., 2022). The macro perspective focuses on education policy, politics of education, and an understanding of socio-economic barriers and enablers, local cultures, embedded traditions, and how these can be negotiated to help create social justice in teaching (Cuervo, 2016). It is particularly important to address the broader issues of poverty, marginalization, and structural barriers to the advancement of disadvantaged groups. Innovative teaching and teacher development address the practical difficulties faced by schools with limited resources; how and to what extent do such schools collaborate well? In this line, Stewart (2022), asserts that children's interest in their locality, innovation to improve the quality of teaching and learning, and the proper utilization of available resources to maximize opportunities for the overall progress of students are social justice in the classroom. Parent and community involvement, addressed both are concerned with how and to what extent schools manage family-centered practices, participatory, and how and to what extent they can capitalize on the support of charities (Fadhillah et al., 2018). Social justice in classroom teaching is about helping students at the right time in a student-friendly environment without discrimination.

Discourse for Student Engagement

Engaging students in stimulating classroom conversations begins with creating a discourse-rich classroom culture. A key factor in building a rich discourse culture is instilling a sense of collaboration, cooperation, and competition among students (Bramley & Morrison, 2022). Classroom discourse is not only a way for students to support each other, but also a way to hold each other accountable by helping them clarify, repeat, and challenge ideas. If the classroom discourse is devalued or ignored the students, do not participate actively and spontaneously (Buckley, 2014). To this end, the establishment of discourse norms helps develop safe spaces, delineate boundaries, and advance classroom discussions.

In some classrooms, rules and regulations are included on how to listen actively, present personal opinions, and respectfully agree or disagree. Discussing appropriate behaviour and inappropriate behaviour in the classroom gives students a better understanding of their expected roles (Finn & Zimmer, 2012). Some students need to speak frequently to confirm their understanding. Some students just sit in silence for fear of being criticized by their peers. Some are apathetic and prefer to think about everything but what's going on classroom to address each type of student is a primary concern of the teacher. Students are diverted to important issues, and integrating their interests, knowledge, and efficiency from informal conversations can help clarify such issues (Kelly, 2021).

Students can be engaged in partner talks like pair-share, turn-and-talk, or small groups before the whole group. More students participate in whole-group talk if first allowed articulating, clarifying, and reorganizing thoughts with a partner (Lazarides, Buchholz, & Rubach, 2018). Teachers should appreciate the student's questions and replies. In the classroom, teachers can feel guilty about finding the best answers in a short amount of time, pressured to follow a pacing guide, and meet targets. A slightly innovative, but certainly effective wait time has been shown to improve not only the percentage of students responding but also the quality of responses (Smart & Marshall, 2013). It is increasingly recognizing the importance of student engagement concerning academic achievement. Arising from this work are many questions and concerns related to both the meaning and justification or goals of student engagement that require philosophical investigation (Portelli & McMahon, 2004). Teachers need to build on each other's communicative behaviour in the classroom (Buckley, 2014). For this, both the teacher and the student need to understand the rules of interaction. It is proposed that student interactions may be constrained by student characteristics, teacher characteristics, instructional processes, and instructional content (Groccia, 2018; Smart & Marshall, 2013).

It is believed that teachers can encourage student participation and engagement with the organized pedagogical discourse in the mathematics classroom and have outlined several strategies. In developing countries like Nepal, classroom discourse should be strategically specific, organized, and targeted to students' needs as textbooks and other resources are not made available to students promptly.

Discourse for Identity Construction

Human communication involves exchanging information, doing things, expressing feelings and emotions, and most importantly, telling each other what kind of people we are, what geographic, ethnic, and social community we belong to, where we stand on moral and ethical issues, and where our political allegiance lies. While we use language to express images of ourselves, we also use it to identify others, categorize people, and make judgments (Fina, Schiffrin, & Bamberg, 2006; MacIntosh, 2021). We always differentiate one from another with common, or differences something having them. In these and many other ways, language and discourse are central to the construction and negotiation of identity (Boaler, 2015). When the relationship between beliefs about success in activities and the ability to engage in activities occurs in an educational setting, and the mathematics classroom, we understand that it is shaped by various influencing factors. Furthermore, as the classroom is a social environment, these beliefs and dispositions, or a mathematical identity, are formed as we interact and participate in the community (Martin, 2006).

A focus on factors within the social environment of the classroom that influence the development of mathematical identity in terms of academic outcomes. A mathematical identity encompasses a person's understanding of himself or herself in terms of doing mathematics (Benwell & Stokoe, 2006; Ladson-Billings, 1990). It covers how others "construct" us concerning mathematics. As a result, a mathematical identity is expressed in its narrative form as a negotiated self, the result of our own claims and therefore the external ascription of sometimes-rival others (Trescott, 2020). The phenomenon of explicit mathematics identification reflects although the socialization experiences of mathematics are understood and internalized to form fifteen people's beliefs about mathematics and themselves as doers of mathematics (Martin, 2003; Safrudiannur & Rott, 2020).

Identity is developed in the context of mathematics discourse as a person's ability to participate and perform as a builder of identity. However, opportunities must be provided for students to have entry points to participate and perform in mathematics. What are the opportunities or factors that allow a student to participate in admissions and perform or not? These are everyday events in the classroom. It is an interaction between the student and the teacher (Meletiadou, 2023). These are the teaching practices and structures employed in the classroom. Teachers and students interact in the classroom, and a limited view of these practices and structures in classroom interactions will arise if we do not take into account the construction of identities in terms of status and power (Trescott, 2020). The student's identity through discourse is said to be participatory, prepared, helpful and good at mathematics, diligent, quick to understand, and confused; as a math teacher, identities are supportive, compassionate, rigorous, knowledgeable, helpful, and physical constructs.

Discourse for Student Empowerment

Empowerment is the acquisition of power by individuals or groups of students in a particular topic or as a whole of learning and the process of empowering them or encouraging and facilitating their acquisition of power (Riyati & Suparman, 2019; Truxaw, 2020). Therefore, the discussion of mathematical empowerment is related to the goals of mathematics instruction in specialized modeling and the goals of the pedagogical update to enhance procedural integration (Thornton & Reynolds, 2006). Classroom discourse for students' empowerment focuses on mathematical, social, and epistemological empowerment. Mathematical empowerment relates to the ability to apply mathematical knowledge and skills in school mathematics (Auletto & Stein, 2020). Social empowerment is the ability to use mathematics for social improvement and epistemological empowerment refers to a person's belief and power to use, create, and validate knowledge (Boaler, 1997). Discourse analysis techniques and models that can be used to better understand and improve linguistically diverse mathematics classrooms are issues of providing equity education and empowering students in linguistically diverse school mathematics classrooms (Truxaw, 2020). The benefits of classroom discourse include clarifying understanding, building persuasive arguments, developing language for expressing mathematical ideas, and learning to see things from different perspectives (Buchheister, Jackson, & Taylor, 2019).

Teachers promote mathematical discourse as a highly profitable strategy for improving thinking skills. Students who question mathematics become better problem solvers and critical thinkers (NCTM, 2000). Teachers need to identify goals, look at student participation, analyze the teaching strategy, and think about how it relates to the classroom discourse, and it is meaning (Anderson-Pence, 2015; Yuniarti, 2017). Empowered mathematics learners can meet all future demands in today's rapidly changing world scenario. Teachers, therefore, have a role to play in developing mathematically literate global citizens (Auletto & Stein, 2020). Productive discourse supports ideas on why, what, and how to support math learners. Students are encouraged to read the chapters carefully before entering into problem-solving, apply some of the ideas generated from the chapter in the problem-solving, and see how these ideas provide a means to real-life problem-solving (Huinker, Bush, & Graham, 2020). Empowerment strengthens students' mathematical abilities, skills, and ideas to understand symbols, mathematical language, expressions, equations, connections, and relationships of different variables. Therefore, mathematical discourse is decisive in enhancing students' learning.

Discourse for Meaningful Teaching

Meaningful discourse enables students to process information, share ideas, listen and respond to others, and collaborate consensually. The discourse involves asking clarification questions, summarizing key concepts, authenticating related ideas, and analyzing conversations (Truxaw, 2020). Planning classroom instruction to encourage student participation in mathematics discourse begins with the decisions teachers make. The actions students use, the way instruction is organized, and the behaviours they use to express the expectations of classroom norms, such as how students should participate in classroom discussions (Kaur & Kaur, 2011). During class, teachers encourage productive mathematical discussion by asking leading questions to prompt or redirect the nature of the conversation. Thus, teachers can motivate and encourage students and intervene strategically to maximize students' learning and mathematical language skills development (Blanke, 2018).

To engage students in productive mathematical conversations, teachers must plan, initiate, and coordinate discourse in ways that enhance student learning. It is not enough to just prepare the content for a math class. Teachers should choose meaningful math problems that provide opportunities for students to participate in in-depth discussions about mathematics. It is important to set up the learning environment and strategies so that students can participate in productive math conversations. Teachers should model student behaviour when working with peers, provide a way to share solutions and strategies, and clearly outline the role and expectations of productive conversation in mathematics instruction (D’Ambrosio, 1993). Students have equal access and opportunity to participate in the math discourse learning peers. Teachers can engage students in mathematical discourse by asking questions that stimulate discussion and debate (Kaur & Kaur, 2011). Teachers can

also ask questions that require students to work on specific aspects of the learning process and to explain and justify their ideas. In meaningful classroom discourse, teachers consciously plan lessons as moderators and engage all the students in discourse. Classroom
members then participate in a listening phase in which teachers provide important information and students participate in receiving the information (Fennema & Romberg, 1999).

Dialectic communication ensures consistent information exchange. Classroom members participate in the listening phase, where teachers and students share information coherently through dialectic communication (Newell & Orton, 2018). During the participation phase, teachers provide targeted opportunities for students to participate in rich discussions that stimulate the overall development of students learning. Classroom discourse focuses more on how students speak, write, and participate in knowledge construction using written and oral language structures. Oral discussion, the primary medium for discourse, builds knowledge, supports linguistically diverse students, and provides a social context for learning (Gee & Green, 1998). Through meaningful classroom discourse, students develop skills such as collaboration and teamwork, critical thinking, problem-solving, creativity, and leadership (Truxaw, 2020). These skills are greatly enhanced by promoting math discussions in the classroom rather than having students take notes and solve problems on their own. Students need to practice speaking and listening, disagreeing appropriately, and explaining their thinking to be successful in real life.

Discourse for Meaningful Learning

Learners learn to relate new events to existing concepts through meaningful processes. Meaning, therefore, is not an implicit response, but an expressed and differentiated conscious experience that occurs when meaningful signs, symbols, concepts, or statements are related to a particular person's cognitive structures (Ausubel, 1962; Blanke, 2018). Meaningful learning is an important form of learning in the classroom. Meaningful learning, therefore, contains new knowledge that is relevant to what the learner already knows and can be easily retained and applied. Ausubel (1962) proposed concept maps to ensure meaningful learning concepts. It is a hierarchical diagram of conceptual relationships that allows students to relate new information to previous knowledge (Ausubel, 1962). Meaningful learning enables students to relate material acquired to previous knowledge and experience, which acts as an anchor for the acquisition of new knowledge. This allows students to make connections that provide lifelong, rich, and lasting learning. Meaningful learning equips students with important cognitive skills that they can use throughout their lives (Ashburn & Floden, 2006). Cognitive skills are what students use to evaluate, analyze, remember, and compare to make learning meaningful.

Furthermore, meaningful learning is the sustained acquisition of knowledge, behaviour, skills, or abilities through practice, study, or experience. Likewise, learning is a natural and continuous process that we perform every day throughout our lives (Keengwe, 2015). Meaningful learning enables students to relate material acquired to previous knowledge and experience, which acts as an anchor for the acquisition of new knowledge (George Saadé & Alkhori, 2011). This allows students to make connections that provide lifelong, rich, and lasting learning. The best ways to make learning meaningful through discourse include connecting content to meaning, encouraging self-testing rather than rote memorization, and frequent low-risk assessments (Keengwe, 2015). There are many ways to understand and define meaningful learning, as it encompasses many facets of cognition, including Active

Learning, Deep Learning, Inclusive Learning, Collaborative Learning, Constructive Learning, Authentic Learning, and Purposeful Learning (Kieran, Forman, & Sfard, 2007). These learning strategies include question-and-answer sessions, discussions, interactive discourse where students answer and ask questions, short writing assignments, hands-on activities, and experiential learning.

Student motivation is essential to achieving meaningful learning. For this reason, when teaching new concepts in mathematics, teachers should consider the student's prior knowledge and use plentiful examples (George Saadé & Alkhori, 2011). The use of resources and materials that facilitate this type of learning is also encouraged. Teachers must consider a student's previous knowledge before starting to teach new concepts. This allows the use of symbols, phrases, concepts, images, ideas, and statements related to new knowledge (Steffe et al., 2013). Through these connections, students have the opportunity to relate what they already know to new concepts being taught in the classroom. Through these connections, the acquired knowledge is stored in long-term memory for personalized and ongoing learning. When meaningful learning takes place, facts are relevant and preserved. That is because they are related, the brain stores them together. When one fact is remembered, at that moment other facts are also remembered (Atherton, 2010). In other words, remembering activates memory, which leads to recall.

Today, discourse takes a different approach. Teachers recognize that students should be actively involved in the learning process. In classrooms that promote the value of discourse, students and teachers share the responsibility of speaking in carefully planned, discussion-based lessons (Fletcher et al., 2022). Students are allowed to have purposeful conversations in the classroom and practice developing and modifying new concepts through explanation, questioning, reflection, synthesis, and debate.

Teacher's Role in the Classroom Discourse

Sinclair and Coulthard (1975) claim that there are five different phases to make the mathematical classroom discourse student-friendly and they are the preparatory phase, introductory phase, elaborative phase, interactive phase, and recapitulation phase. An experienced teacher prepares the lessons with objectives, designs, and instructional activities to achieve the objectives, collects or prepares teaching materials for classroom use, and sets himself/herself for the delivery of instruction on the related subject matter. Here, the teacher is already prepared for classroom activities but students are not prepared, therefore the teacher has a clear concept about the subject matter but students do not have it. These preparations are included in the preparatory phase.

In the second introductory phase, the classroom activities are performed by the teacher. The teacher provides outlines for classroom assessment and manages the teaching procedures. In this stage, the teacher introduces the topic, organizes activities, reflects objectives and motivates students toward the lesson, uses appropriate methods of teaching according to the situation, creates a warm environment in the classroom, and builds up relations in the class by linking student's knowledge and concepts with the lesson and provides opportunities to explore the new ideas. In the third elaborative phase, the teacher elaborates on the ideas and topic, provides clues and hints for difficult concepts and ideas, gives encouragement, makes optimum use of prepared materials for effective teaching, responds to the students, reduces confusion, and makes the simplicity to the complexity.

In the fourth interactive phase, the teacher provides extended activities to strengthen students’ ideas, rewards learners’ attempts and success, speaks, writes, and communicates, engages all the students in the classroom activities, links ideas, and activities of the lesson, and gives responses and feedbacks, creates a pleasant learning environment. In the final phase, the teacher recapitulates his/her views, evaluates students’ classroom achievements, summarizes the entire lesson, gives the students home assignments for further tasks, and concludes the lesson systematically.

To facilitate students’ participation in the content of mathematics courses, teachers' decision and planning plays a vital role. Teachers should facilitate the transition to the classroom through extensive mathematical dialogues and prepare students for active participation. It is also important to carefully consider how to best coordinate student interactions in pairs, small groups, or across classes to facilitate the transition and maximize learning outcomes. To support students, teachers need to help students shape their perceptions of expected behaviours and actions. To prepare for their role through simulation or role-playing, teachers should monitor the progress of students in mathematical discussions and help them improve their mathematical skills and better express their vocabulary, grammatical, and semantically accurate views. Determining the question to ask, which student to call, when to intervene, and when to expand the student's thinking ability provides opportunities for understanding students' thinking, tracking student growth, and assessing knowledge. It is necessary not only to obtain information about what students know but also information about the methods they are using, and how to better understand the ideas and methods of knowledge. In addition to meaningful knowledge, the mathematics curriculum also enables teachers to monitor the temperament of students and measure their self-confidence, interest, and perseverance. Teachers can use this information to identify areas of confusion or frustration and determine when intervention is needed. In addition, check the understanding and misunderstanding found in the classroom discourse and adjust the lesson plan accordingly.

Student's Role in the Classroom Discourse

Students are active participants in the mathematical classroom discourse to transfer knowledge. In creating a strong learning environment in the classroom, the role of the student is as important as the role of the teacher (Piscitelli, 2020). Students are collaborative and enthusiastic in the teaching-learning process. In the preparatory phase, students prepare themselves for learning activities. They put out their textbooks, reference books, exercise books, pens, pencils, erasers, and sharpeners and get ready to learn from the teacher. In this phase, students manage different reading, writing, and drawing materials in their access. If one does not have any equipment, they borrow from colleagues.

In the second understanding phase, students mostly keep silent and try to understand the subject matter that the teacher explains. They make notes, list the symbols and formulae, and note the key points. In the third exercising phase, the teacher provides some sort of classroom assignment and students think over it. Students try to do the exercise depending on their understanding, concepts, and knowledge. This is the phase of displaying the understanding of students. If some of the students could not understand the concepts, they asked their colleagues, to use their knowledge, skills, cognition, and intelligence. Students compete among themselves in small groups or whole classes to be the first ones in the classroom to show their competency and try to dispose their understanding carefully of what was taught by their teacher. In this phase, students interact among themselves and collaborate, may/may not copy from friends, and hurry up to show their work to their teacher. They expect positive feedback from their teacher and try to prove the best, most active, and smart working habits among all.

In the third questioning phase, if some students cannot complete their tasks due to confusion, misunderstanding, misleading, slow learning, or misconception, they question friends and teachers for assistance. The students who could do the assignment, the question for extending their knowledge on the topic, overcame the confusion and tried to be perfect on what was taught. Finally, all the students understand the topic, clear the concept about the topic, and become happy and feel proud having learned that is the saturation phase.

Discourse in the Construction of Knowledge

Classroom discourse refers to contextualized or situated language use in classrooms as a specific interactional context that reflects cultural and social practices. Interest in classroom discourse analysis has grown with an enhanced understanding of the mediating role of talk in learning as a high-level mental activity (Luk, 2017). The teaching and learning of mathematics is, however, a process that, perhaps more than any other subject, depends on the language. Abstract mathematical ideas are brought into being through classroom talk or writing (Barwell, 2008). To this point, Lyle (2008) suggests that mathematics discourse is one in which the world is a discursive construction and the mind is embedded in contexts that have unique historical, political, cultural, social, and interpersonal determinants. Learning is seen as a social process and knowledge is jointly constructed or shared by teachers with the students through the discourse process (Loveless, 2013, May 20). Collaborative talk is, therefore, a means by which dialogic engagement between learners can become a tool for meaning-making.

Discourse in mathematics is only the way of sharing knowledge from knower to knowing in their sociocultural backgrounds. From the discursive process, mathematical knowledge is spreading throughout the world and hence constructed through the collaborative process in the classroom. It is agreed that knowledge never dies, it is true, but to establish the immortality of knowledge, the continuity of knowledge must be passed from one generation to the next, which is possible only from the classroom discourse (Ozmon & Craver, 1990). Therefore, classroom discourse is the heart of the sharing and construction of knowledge in the field of mathematics by applying existing theories, methods, and cultures (Robinson, 2015). Furthermore, I see that mathematics is a universal language and it is the art and science of problem-solving in real life. Thus, the role of classroom discourse is on top of all the processes of sharing knowledge and making beautiful minds in the societies that are creating the beautiful world where we live today.

Research Focus on Discourse

Research in mathematics education has two main goals. The first is to better understand the nature of mathematical thinking, teaching, and learning. Second, using this knowledge in mathematics learning and teaching. Mathematical discourse involves clarifying understanding, constructing persuasive arguments, developing language to express mathematical ideas, and learning to see things from different perspectives (Catalano & Waugh, 2020; Wodak & Meyer, 2009). Mathematics discourse uses both mathematical and literary language. Discourse studies examine the study of written or spoken language concerning its social context. It helps to understand how language is used in real-world situations. Rather than focusing on small units of language such as sounds, words, or sentences, discourse analysis is used to examine larger chunks of language, such as entire conversations, texts, or collections of texts (Langman & Hansen-Thomas, 2017). Selected sources can be analyzed at several levels. Academic discourse, therefore, provides a data source for early assessment and can be used by teachers to monitor students' understanding of mathematical concepts along with language use.

Teachers engaging in discourse in mathematics classrooms are more likely to engage in exercises that help students visualize their thinking. Teachers engage students in mathematics discourse by asking questions that stimulate discussion and debate. Depicting strategic prompts and questions that challenge students to address specific aspects of the learning process, explain and justify their ideas, and develop a better understanding of the process (Elmansy, 2023). Exploring instructional discourse, investigating learning challenges, understanding individual differences and preferences, and developing instructional methods for the needs of individual learners play an important role in advancing curriculum development and innovation (Renkema, 2009). It also plays an important role in helping students make important connections between physical, pictorial, graphic, symbolic, verbal, and mental representations of mathematical ideas.

From research on mathematics classroom discourse, if it is identified as a good way of discourse, it can be applied in mathematics classrooms around the world because mathematics is the same worldwide, and mathematics can act as a universal language. A statement or expression has the same meaning as it has in other languages (Taiwo, 2010). Exploring discourse in mathematics classrooms sheds light on what kinds of discourse are useful to students and how the effects of active student engagement in the classroom can make classrooms effective and meaningful (Titscher & Jenner, 2000). Therefore, it is very important to examine the discourse of mathematics education to identify appropriate modes of communication between teachers and students to make learning meaningful, permanent, vital, and lifelong

Research Gap

After reviewing dozens of scholarly works mentioned above, and dissertations of national and international scholars, I realized that this knowledge was different from my concept and my study issue. I found that various scholars raised issues such as cultural relevance, contextualization of mathematics teaching, the effectiveness of teaching mathematics in the mother tongue, inclusion of everyday activities in the mathematics curriculum, teachers' practice, examination system, and student engagement. Scholarly works ranged from classroom culture to classroom discourse, social justice in mathematics teaching, teacher and student ideologies, and many other topics. I tried to find out whether there are scholarly works related to and its relation to mathematics teaching-learning in the classroom. No matter how hard I tried, I could not find the exact connection between the classroom discourse and the existing culture of student diversity, and further examination is necessary in the context of Nepal. In this context, I would like to conduct a research work entitled “Pedagogical Discourse in Mathematics Classroom" which is new in the field of contemporary research. Therefore, I believe that this research topic is relevant, preliminary, and researchable in the context of Nepal.

Theoretical Underpinnings in My Research

The theoretical foundation is the “blueprint” for the entire dissertation inquiry (Grant & Osanloo, 2014). The process of this study has been founded on four major theoretical underpinnings – cultural capital theory (Bourdieu, 1986), sociocultural theory (Vygotsky, 1978), critical Pedagogy theory (Freire, 1970), and multiple intelligence theory (Gardner, 1983, 1993). Each of these theoretical foundations has been discussed in terms of their major roles in education in general and discourse in mathematics classrooms in particular and promote equity, justice, and access to high-quality mathematics education to all students.

Cultural Capital Theory

Bourdieu's (1986) notion of cultural capital provides a theoretical framework to explain the challenges faced by teachers and students in the classroom discourse due to cultural variations. Although cultural capital is also acquired in school, family and society are the first places where children learn the fundamental cultural dispositions that are basic to their schooling (Khanal, 2017). Similarly, Bourdieu (1973) contended that the school system rewards students' cultural capital, and the ultimate reward is in the form of educational credentials. Bourdieu's theory of social reproduction and cultural capital assumes that student culture is transferred and remunerated by the educational system. In order to acquire cultural capital, students must be able to acquire it and internalize it (Dumais, 2002). Cultural reproduction theory provides powerful enlightenment on why some children are better academically than others. Bourdieu argued that cultural capital, or familiarity with the dominant cultural codes in society, was an important factor in the success of education. Furthermore, children of higher socioeconomic status have more cultural capital than children from lower socio-economic backgrounds, and have a comparative advantage in the education system, thereby depriving them of privileged social reproduction (Bourdieu, 1977; Dumais, 2002; Jæger & Møllegaard, 2009).

Bourdieu further asserts cultural capital includes all non-financial social assets such as language, vocabulary, and social mobility of children. If these cultural characteristics align with the mainstream school culture, they facilitate the academic success of the students. Bourdieu's concept of habitus is an important aspect of cultural capital, it is a socialized norm or tendency that guides behaviour and thinking (Khanal, 2017). Richards and Camuso (2015) argue that schooling is an important mechanism for reproducing class-based power and privilege. Students can broaden their knowledge of the class-based experiences, values, beliefs, behaviours, and attitudes of dominant groups as cultural capital. Children acquire this cultural capital from their families and throughout their lives, as communication styles and forms of social interaction within the family are similar to those taught in school to children from privileged social groups.

In mathematics teaching, ethnomathematics examines the relationship between mathematics teaching learning and the culture of individuals. Bourdieu used the term cultural capital in different ways to emphasize its embodied material and relational aspects in education. The term "institutionalized" refers to broad, high-level cultural cues (behaviours, preferences, formal knowledge, behaviours, goals, competencies) used for social and cultural exclusion (Lareau & Weininger, 2003). It suggests enhancing existing skills such as knowledge, vocabulary, and linguistic skills. Cultural activities such as participating in art and music classes can improve children's analytical skills (Kisida, Greene, & Bowen, 2014), and extracurricular activities can improve intellectual creativity (Kaufman & Gabler, 2004), social emotions, communication, and social skills promotes real-world knowledge for lifelong existence (Lareau & Weininger, 2003). Furthermore, it has been suggested that reading for fun, which is also an essential aspect of cultural capital, can improve academic skills such as language proficiency and broader cultural knowledge integration in mathematics classroom discourse (Blanchard & Atwill, 2017).

The interpretation of cultural capital theory implies that cultural capital not only works through cues but can also improve academic success through hands-on skills (Kaufman & Gabler, 2004). Children's performance in art, athletics, club participation, and reading, as measured by prior achievement in reading mathematical language and symbols, participation in group works of problem-solving, participation in discussions, and classroom discourse (Kingston, 2001). This is consistent with the notion that a literary environment within the home fosters children's skills such as complex vocabulary, creativity, and cultural knowledge that improve academic performance (Graaf, Graaf, & Kraaykamp, 2000; Kaufman & Gabler, 2004).

Cultural capital refers to home educational resources that enable students from privileged backgrounds to learn attitudes, values, perceptions, knowledge, and skills valued by school teachers (Yosso, 2020). It includes values and attitudes that promote learning and the value of academic persistence. The student's culture supports the preference for intellectual tasks (eg, watching documentaries) and; the acquisition of academic competencies and skills (higher-order reasoning skills, cultural capital, self-awareness of socio-economic context, etc.) (Gaddis, 2013). Students with these characteristics may therefore benefit from schooling (Bourdieu, 1986). Through culturally sensitive teaching and the use of students' cultural capital, students have made mathematics problems accessible and helped them interact with each other in culturally appropriate ways (Dumais, 2002). Mathematical concepts grounded in a cultural perspective enable students to consider and understand not only their own culture but also other cultures and traditions. Involving community members is an essential part of integrating cultural elements into math activities.

Cultural capital theory supported me in understanding how individual students' different cultures help them achieve academic success in mathematics and how teachers should acknowledge students' knowledge, skills, behaviours, and understandings in mathematics classroom discourse. If mathematical discourse is initiated by students' embodied cultural connections, students' active participation in mathematical discourse makes it easier to grasp mathematical concepts.

Sociocultural Theory

Mathematics teachers and researchers view mathematics teaching as a process of social interactions in the classroom with students. The students talk about their learning; negotiate and exchange ideas to arrive at a culturally agreed understanding of mathematics. The teacher's sociocultural approach builds the context to teach the students the scientific language of what they are doing; able to extend the ordinary language used by students to construct mathematical language. It is believed that students should be involved in learning mathematics by participating in the creation of the cultural meaning of mathematics. Classroom discourse includes speaking, listening, responding, writing, performing, observing, participating in social interactions, sharing ideas with others, and debating when others share their ideas. The communication process also helps to give meaning and permanence to ideas and make them public. Mathematics learning is not beyond the societal and cultural activities that go on in our community, therefore, the activities connecting to culture and society are socio-cultural.

Similarly, Vygotsky's (1981) sociocultural theory states that infants are born with certain essential mental functions, including attention, sensation, perception, and memory, which are eventually transformed by the culture into new and more sophisticated mental processes known as higher cognitive functions. Every culture provides opportunities for children to grow intellectually through interactions with more competent members of society, for ways of thinking and problem-solving

(Berger, 2004, 2005). In addition, Berger noted that in many cultures, children do not learn by going to school with other children, nor by their parents in informal orchestrating such as knitting and hunting, but they also learn a lot from their own intuition. Vygotsky (1978, 1995) argues that they learn through directed participation in cultural activities. With this learning to think and contextualization of independent learning, children question themselves and adults and enhance their knowledge. A learner can learn a lot of things with their own experience and/or from the influence of more knowledgeable peers.

Mathematics can also be learned by playing with numbers, collaborating with peers, teachers' special guidelines, and sociocultural activities concerning the subject. Children are interested in learning challenging and new things but if the challenge is too great, the student may simply quit (Cherry, 2018). By understanding the concept of the psychological behaviour of learners, zones of proximal development, and how to connect with students at different developmental points, teachers can plan a more strategic approach to group and individual instruction (Hudson, 2013; Walshaw, 2017). The Zone of Proximal Development (ZPD), often referred to as the optimal learning zone, is a concept that elaborates on how learners can learn creatively.

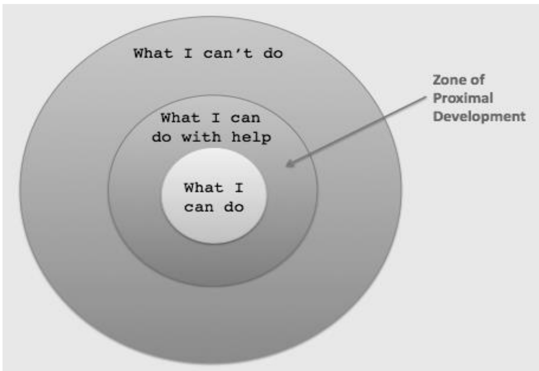


Figure 1. My Illustration of ZPD

Vygotsky (1978) positions that ZPD is the disparity between the actual level of development, determined by independent problem-solving skills of individual efforts; and the potential level of development, determined by problem-solving under adult supervision or in collaboration with older peers. It is the gap between what a student knows and what they can achieve with appropriate and academically sound guidance and support (Acharya, 2015; Cherry, 2018). Each student is unique and has different areas based on context, each individual's prior knowledge, and interests. Learning within the ZPD should not be too easy or too difficult (Hudson, 2013). It should be challenging enough to help the student sharpen conceptual understanding and develop new skills that build on the student's existing knowledge and understanding.

Children can develop mathematical skills and concepts through their sociocultural behaviour when they are given opportunities to talk about their understanding of mathematics at home and in schools. Students build stronger ideas about mathematics through social interactions with more knowledgeable people. Students negotiate and exchange ideas to arrive at a culturally agreed-upon understanding of mathematics (Hudson, 2013). The socio-cultural perspective of the teacher constructed the context to provide the students with the scientific language of what they were doing. The teacher must be able to expand the general language that students use to construct their mathematical language because it is believed that students need to engage in mathematics learning by helping to create the cultural meaning of mathematics (D'Ambrosio, 1998; Robbins, 2001; Walsh & Li, 2013).

Vygotsky's Theory of Concept Formation (1995) is a powerful framework for studying how school-aged individuals construct new mathematical concepts. In particular, this theory can bridge the gap between individual mathematical knowledge and the socially accepted body of mathematical knowledge ((Das, 2019; Newell & Orton, 2018). It can also be used to illustrate how idiosyncratic uses of mathematical symbols are transformed into mathematically acceptable uses by students to grow achievement of meaningful mathematical concepts by individuals (Walsh & Li, 2013). Communication is critical to deepening mathematical understanding. From a socio-cultural perspective, students who share reflections on ideas and listen to others create an understanding of the culturally established mathematical practices of sharing their ideas (Hudson, 2013).

Vygotsky (1994) claims that communication is a cultural tool. Furthermore, language is a cultural means of human communication means. For Vygotsky (1998), individuals learn the meaning of culture by internalizing and transforming it through meaning while learning to speak the language of the culture. In this way, students learn to explain and justify their ideas to others while creating their own knowledge and developing mathematical meaning (Solovieva & Garvis, 2018). Learning to speak the language of mathematics will change the way you think about mathematics concepts. Mathematical language comes from society, and thinking (concepts) comes from individuals (Markee, 2015). Sociocultural theory contributed to how mathematics is taught and learned from the sociocultural contexts of learners. Students' sociocultural understanding is supported in the collection of data and meaning-making from the analysis of obtained data.

Critical Pedagogy Theory

Critical pedagogy theory (Freire, 1970) advocates that teachers should encourage students to examine power structures and patterns of inequality by developing critical awareness to free them from oppression. A central tenet of Freire's critical pedagogy is critical cognition that precedes action. Critical awareness begins when students become aware of socio-political injustices and take steps to alleviate those contradictions (Freire, 1985). Critical pedagogy is a philosophy that aims to apply principles of critical social theory to education and study how schools reproduce inequality and injustice (Beck, 2005). Students can learn by critiquing texts and examining injustices within them (Giroux & Simon, 1988). The role of language in creating injustice, arguing that those in power can "name the world" (Freire, 1993). Through their words, elite groups impose their will on the powerless. Freire says that a container must be filled but the students are not meant to be filled like a container, they should be irrigated with a critical awareness that only the teacher can give them (Friere, 1970). Freire saw the 'container' model as a 'bank formation concept' (Fiere, 1970).

Freire criticized the "banking" model of education, which sees students as empty, inferior, passive recipients of the teacher's knowledge. Freire advocated that this approach discourages critical thinking and dehumanizes both students and teachers (Miedema, 1994). Students have the power to control their goals, actions, and destinations. Learning happens through problem-solving (Stanistreet, 2021). Learning should be both theoretical and practical. The teacher should not be the authoritative arbiter of knowledge. New opportunities are created when students and teachers learn together. Learning is a never-ending process (Copping, 2013). Knowledge must be related to and developed in the lived experience of participants. Knowledge must be co-created among all participants in the learning process and education is inherently political.

From an academic perspective, critical literacy is when certain areas of thought, thought and research are consciously or unconsciously accepted, rejected, or ignored as not originating from the ruling or elite (Giselsson, 2020; Malott & Porfilio, 2011). Critical pedagogy develops from elements of critical literacy in the classroom and encourages students to question issues of power. Socioeconomic status (SES), race, class, gender, sexual orientation, and age are the burning issues in education (Cervetti, Pardales, & Damico, 2001). This approach requires students and teachers to acquire the necessary knowledge, skills, and disposition to read and critique messages to understand why certain knowledge belongs to a privileged class (Malott & Porfilio, 2011). Further promoting critical literacy development encourages investigation and correction of social contexts, exposing students to the biases and hidden intentions inherent in texts (Godhe, Lilja, & Selwyn, 2019). Furthermore, (Edberg, 2018) states the teaching of critical literacy begins with questions of culture and knowledge in texts, justice, and critique (p. 157). We need to understand how inequality and injustice are socially constructed (Cervetti, Pardales, & Damico, 2001). Students and teachers, therefore, need to be conscious to question previously accepted truths and judge their current validity.

From the critical pedagogy theory, I understand that learning is to develop critical competencies. Learners need to think critically about what they read, watch, and hear, and be able to identify inequalities and injustices. Encourage active inquiry and curiosity-based participation. Discouraging active inquiry in the classroom deprives learners of the opportunity to develop into mature, autonomous individuals and encourages them to think critically to make their world a better place (Lowan-Trudeau, 2017). I also learned as a teacher that classroom discourse should start from the perspective of the student rather than the perspective of the teacher. The critical pedagogy theory contributed to framing the concept of collecting data through observation of the classroom's discourse, in-depth interviews, and focus group discussions. When discussing, conversing, and asking questions, it is necessary to understand the social and cultural background of students and teachers more than their bookish knowledge.

Mathematical-Logical Intelligence Theory

"*An intelligence is the ability to solve problems, or to create products, that are valued within one or more cultural settings*."

Gardner (1983, p. xxviii)

The theory of multiple intelligences (Gardner, 2010) developed by psychologist Howard Gardner posits that individuals possess eight or more relatively autonomous intelligences. Individuals draw on this intelligence, individually and corporately to create products and solve problems that are relevant to the societies in which they live. In a similar context, Davis, Christodoulou, Seider, and Gardner (2011) claimed that the eight identified intelligence include linguistic intelligence, logical-mathematical intelligence, spatial intelligence, musical intelligence, bodily-kinaesthetic intelligence, naturalistic intelligence, interpersonal intelligence, intrapersonal intelligence.

Table 2. *Gardner's Eight Bits of Intelligence*

Intelligence	**Description**
Linguistic	An ability to analyze information and create products involving oral and written languages such as speeches, books, and memos
Logical-Mathematical	An ability to develop equations and proofs, make calculations, and solve abstract problems.
Spatial	An ability to recognize and manipulate large-scale and fine-grained spatial images.
Musical	An ability to produce, remember, and make meanings of different patterns of sound.

Naturalist	An ability to identify and distinguish among different types of plants, animals, and weather information that are found in the natural world.
Bodily-Kinaesthetic	An ability to use one's own body to create products or solve problems.
Interpersonal	An ability to recognize and understand other people's moods, desires, motivations, and intentions.
Intrapersonal	An ability to recognize and understand his or her moods, desires, motivations, and intentions.

(Gardner 1983; Kornhaber, Fierros, & Veneema, 2004)

Gardner's theory of multiple intelligences can be used for curriculum development, lesson planning, curriculum activity selection, and related assessment strategies. Strategies adopted to help students develop their all-aroundness can also inspire their confidence to explore areas where they are not as strong. Students' diverse learning preferences can be accommodated when instruction includes a range of meaningful and appropriate methods, activities, and assessments (Phillips, 2010). Gardner and Hatch (1989) argued that integrating pedagogical theories, teaching strategies, and other pedagogical tools in meaningful and useful ways better addresses students' needs. Gardner himself asserts that when designing lessons, teachers should not adhere to any particular theory or pedagogical innovation, but should apply personal values that meet their teacher and student needs (Chen, 2009). Considering students' multiple intelligences and potentials can help teachers personalize their teaching and assessment methods (Chen, 2009; Phillips, 2010). Intelligence is knowing what comes through languages; through reading, writing, and speaking. It is about understanding the order and meaning of words in speech and writing and using language correctly (Davies, Christodoulou, Seider, & Gardner, 2011). Fogarty and Stoehr (1995) found that logical-mathematical intelligence uses numbers, mathematics, and logic to find and understand various patterns that appear in our lives: thought patterns, number patterns, visual patterns, colour patterns, etc. It starts with concrete patterns in the real world but trying to understand the relationships of the patterns we see becomes more and more abstract. Schools often strive to help students develop a sense of achievement and self-confidence.

Gardner's theory of multiple intelligences provides a theoretical basis for identifying the different abilities and talents of students. This theory acknowledges that while not all students may be verbally or/and mathematically gifted, children may have expertise in other areas such as music, spatial relations, or interpersonal knowledge. Access to and assessment of learning in this setting allows a wide range of students to successfully participate in mathematics classroom learning. From this theory, I learned that students have different learning abilities and desires and learn accordingly. To address cognitively, socio-culturally, and interestingly diverse students; appropriate pedagogic activities must be designed and teachers must always be prepared to psychologically adjust their roles as teachers, motivators, caregivers, observers, performers, actors, participants, promoters, representatives, controllers, and authoritative power holders.

Gardner's theory of multiple intelligences helped me understand the reality of the classroom that no student learns the same way. Therefore, teachers need to understand the underlying realities and develop appropriate strategies to deal with learning variability. When creating research designs, I realized the need to imagine and incorporate the diversity and intelligence of student learning. While collecting information, I tried to include all types of students with different levels of learning ability, interest, and intelligence. I tried to broaden the horizons of students with multiple intelligences and broaden their influence in classroom learning activities in mathematics.

Conceptual Framework

A conceptual framework delivers a logical structure of connected concepts that provides an image or graphic demonstration of how ideas in a study relate to each other within a theoretical framework (Grant & Osanloo, 2014). It is not just a sequence of concepts, but a way of identifying and creating epistemological and ontological worldviews and standpoints to study. Conceptual frameworks also allow for specifying and defining concepts within problems (Luse, Mennecke, & Townsend, 2012). The conceptual framework is prepared through a facilitated literature study to accomplish the research objectives and answer the research questions (Acharya, 2017).

Analyzing various works of literature related to making mathematical classroom discourse student-friendly in culturally diverse classroom settings, I developed a conceptual framework that modifies Sinclair and Coulthard (1975) as shown in the figure below.

Figure 2. My Conceptual Framework Gluing Research Elements

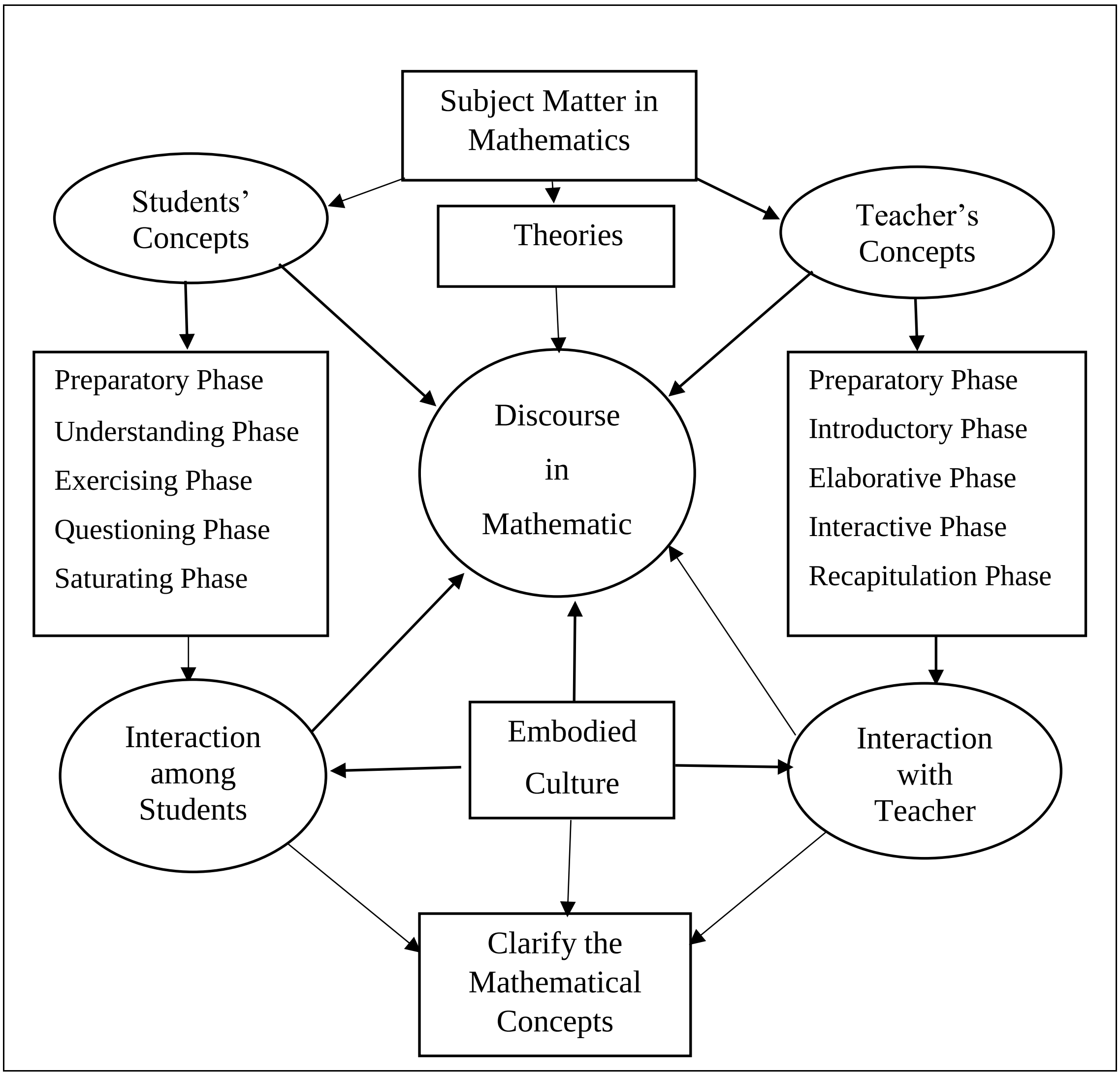
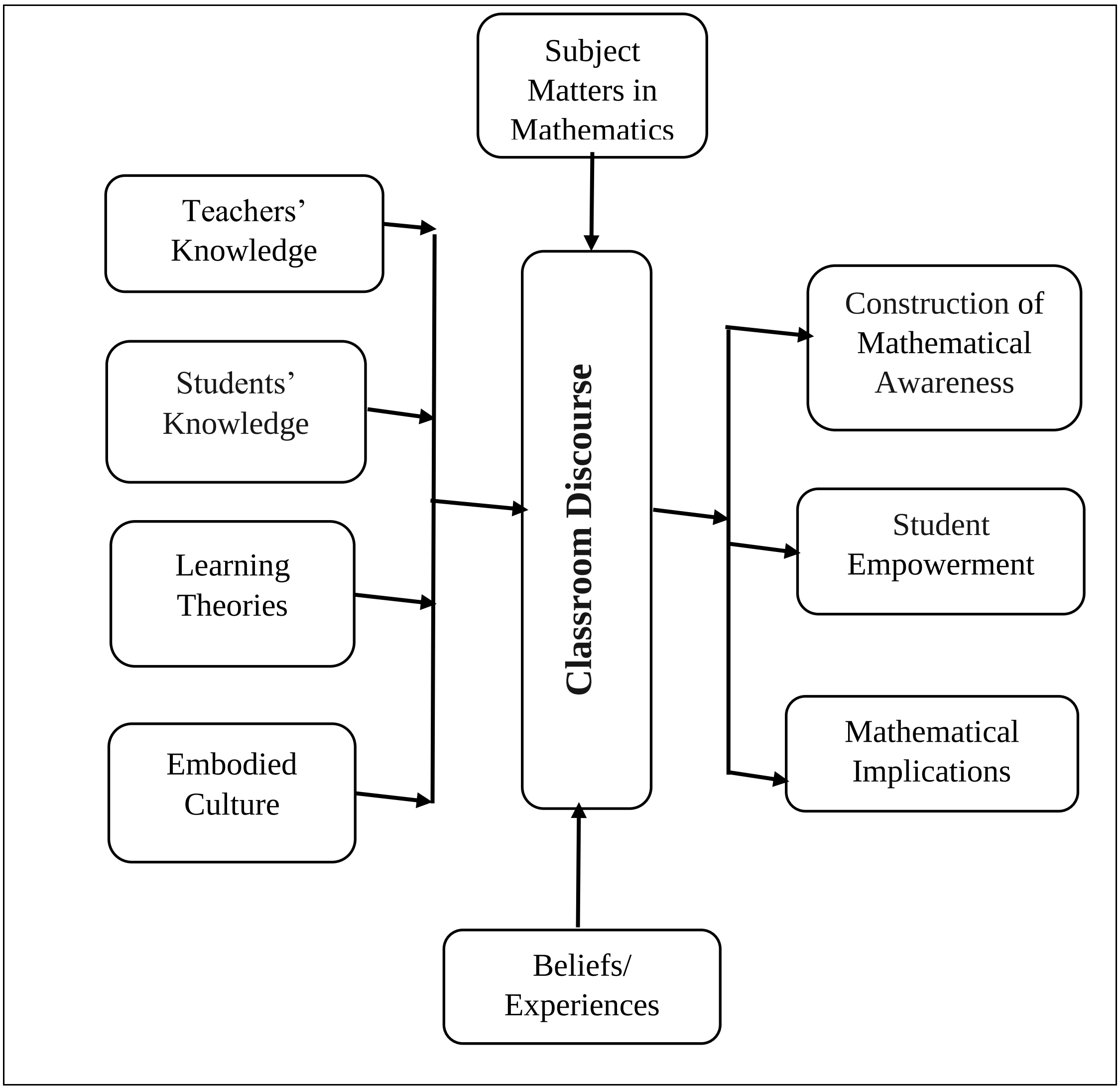


Figure 3. My conceptual Framework Showing Input and Output Factors



In the conceptual framework diagram, there is "subject matter in mathematics" on the top of the diagram because the classroom discourse is performed under a certain subject matter, and without the subject matter the discourse is not meaningful and objectified. The students and teacher both have some sort of concepts and in my opinion, students' concepts may/may not be clear but teachers have a clear concept about topics. The teacher introduces the subject matter to the students or the teacher wants to know the concepts of the students. There is oral or written classroom discourse among students, students, and teachers in an individual, small group, or whole classroom. This discourse is oriented toward finding the solution to the problem, the way of the problem-solving method, or clarifying the concept.

The schematic diagram above outlines the input, process, and output of my study. The input section includes teachers' knowledge, students' knowledge, learning theories, and embodied culture. The Process section contains subject matters in Mathematics, beliefs and experience of mathematics teaching-learning, and Classroom discourse in mathematics. The output section consists of constructing mathematical awareness, student empowerment, and mathematical implementations. The process section plays a major role and interconnects all the input and output elements. Underlying all the elements and agents of the conceptual framework is the core purpose of classroom discourse in mathematics.

Chapter Summary

In this chapter, I reviewed scholarly works of journal articles, books, un/published dissertations, abstracts, references, symposium papers, and presentations to reveal the research gap. During this literature review journey, I collected and explained the essential scholarly views thematically. Twenty-five major themes were described systematically and scientifically. The major themes included a thematic review, theoretical underpinnings in my research, and the conceptual framework. Under the thematic review, I thematically included envisioning of classroom discourse, discourse in a mathematics classroom, the benefit of classroom discourse in mathematics, univocal discourse, dialogic discourse, power of discourse in mathematics, pedagogy of classroom discourse in mathematics, learning mathematical concepts through classroom discourse, the diverse social scenario of Nepal, cultural pluralism, social and cultural diversification, mathematical discourse within cultural diversity, the discourse of ethnomathematics, and discourse for social justice, social engagement, identity construction, student empowerment, student empowerment, for meaningful teaching and learning.

Some recent national and international articles were examined in great detail as part of the empirical literature review. To apply various theories to design this study, I organized the theoretical foundations of my research and carefully clarified the cultural capital theory, sociocultural theory, critical pedagogy theory, and logical-mathematical intelligence theory relevant to my study. I have schematically organized the conceptual framework including the teacher's role in the classroom, the student's role in the classroom, and the role of discourse in the construction of knowledge. The conceptual framework shows the key elements and agents that interconnect the inputs, processes, and outputs of the study. From scholarly works on cultural capital theory, sociocultural theory, critical pedagogy theory, and multiple intelligences theory, I developed a conceptual framework that I believe guides me toward the destination of my study objectives.

CHAPTER III

RESEARCH METHODOLOGY

A methodology is the overall procedure of research. It includes the research paradigm, research design, study site, samples and sampling, information collection tools, procedure, and data analysis strategies. This chapter discussed the research paradigm (ontology, epistemology, and axiological position), research design, study site, participants' selection strategies, information collection and analysis, and ethical consideration briefly.

Research Paradigm: Constructivism

The word paradigm has been interpreted differently by different scholars. Thanh and Thanh (2015) describe their research paradigm as consisting of three elements. It is a standard of beliefs, methodology, and responsibility regarding the nature of knowledge. Neuman (2000) and Creswell (2003) refer to paradigms as epistemologies, ontologies, and research methodologies. Mackenzie and Knipe (2006), in various interpretations, classify adaptable theory, and paradigms into positivism, post-positivism, constructivism, interpretivism, transformative, emancipatory, critical pragmatism, and de/constructivism. For Marsh and Furlong (2002), these attitudes are as important in teaching and research as they shape approaches to theory and methods. And they are so deeply rooted in the researcher's worldview that as a result, they cannot change their stance on these issues (Guarino & Giaretta, 2009). It's more like leather than a sweater. It cannot be placed or removed at the self-control of the investigator. It is also strongly believed that research paradigms shape the nature of research.

Similarly, Creswell (2003) and Yanow and Schwartz-Shea (2011) argue that constructivist researchers discover reality through the thoughts, backgrounds, and experiences of participants. Constructivists understand the world of human experience (Cohen & Manion, 1994, p. 36). The constructivist paradigm and qualitative methodology are closely related, as one is a methodological approach and the other a means of information collection. Researchers using constructivist paradigms and qualitative methods look to personal experiences and perceptions for information rather than relying on statistical data. A paradigm is a set of shared beliefs and agreements among researchers about how a problem should be understood and addressed (Kuhn, 1962). In a similar context, Guba (1985) states that research paradigms can be characterized through these lenses. Ontology is about what is reality. Epistemology is about how you know something. And the methodology is about how you go about finding it out.

The diagram below explains the above-mentioned terms and the relationship between them.

Table 3. *Paradigm Concept*

Ontology	**Epistemology**	**Theoretical perspective**	**Methodology**	**Methods**	**Sources**
What is reality? →	What and how can I get reality/ knowledge? →	What approach can I use to get knowledge? →	What procedure can I use to acquire knowledge? →	What tools can I use to acquire knowledge? →	What information can I collect?

In the vision of Patel (2015), constructivists believe that there is no single reality or truth, and therefore reality needs to be interpreted so that they are more likely to use qualitative methods to get those multiple realities.

After visiting a series of scholarly works, I followed the constructivist paradigm to lead my study. As a constructivist, I think that there are social agents in classrooms (i.e. students and teachers) and they work together with classmates or teachers to construct knowledge. Thus, mathematical knowledge is constructed through interactions between subjects in society. This knowledge is modified and transferred between students.

Constructivist theorists (Bruner, Dewey, Glasersfeld, Piaget, and Vygotsky) believe that social setting, culture, environment, and context play an important role in constructing knowledge (Ernest, 2002; Parajuli, 2021). Knowledge is actively constructed through a personal and social process. Learning is a systematic process in which new knowledge is combined with old knowledge to construct new meanings and understandings (Berzonsky, 1994; Glasersfeld, 2008). Learning is based on personal experience because different people understand "truth" differently (Davin & Donato, 2013). The concept of reality begins with individual explanations and experiences. Learning is socially situated and enhanced by meaningful context. Situated learning focuses on giving meaning to the real-world activities of everyday life (McCarty & Lee, 2014).

Language plays an important role in learning because knowledge exchange takes place through communication. Motivation is the key to learning in constructivism as people want to actively participate in learning and reflect on their prior knowledge. A student's knowledge, experience, beliefs, and preconceptions are important foundations for his continued learning (Prawat, 1999). Teachers are more likely to be successful when they understand that peer engagement is critical to learning. Learning in constructivism recognizes that social interaction is the key to learning and uses interactions and collaborations to help students retain knowledge (Ernest, 2002). Teachers need ways to engage and motivate students to activate their minds and get excited about learning. Without motivation, students have difficulty drawing on their past experiences and making connections for new learning.

There are three forms of constructivism: cognitive constructivism (Jean Piaget), social constructivism (Lev Vygotsky), and radical constructivism (Ernst Von Glaserfield). Among these constructivists, I dealt with social constructivism. Social constructivism believes that learning is an inherently collaborative and social process. According to social constructivism, students develop knowledge through their interactions with their peers, culture, and society (McCarty & Lee, 2014). Therefore, learners rely not only on themselves to construct knowledge but also on others. Social constructivism focuses on the collaborative nature of learning. Knowledge develops from the way people interact with each other, their culture, and society as a whole (Cohen & Manion, 1994). Students rely on others to help them create their building blocks, and learning from others supports them in constructing their own knowledge and reality. Cognitive constructivism assumes that students actively construct knowledge based on their existing cognitive structures (Atherton, 2010). Therefore, learning is relative to their stage of cognitive development (Hruby & Roegiers, 2012). Depending on the age of the students, the curricula in the different grades are designed, organized, and handled differently (Zevenbergen, 1996). Cognitive teaching approaches aim to help students integrate new information into existing knowledge and enable them to make appropriate changes in their existing intellectual framework

Ontological and Epistemological Position of My Research

Ontology is a branch of philosophy concerned with the assumptions of what is real, or the very nature or essence of the social phenomenon we are investigating (Kivunja & Kuyini, 2017; Scotland, 2012). It is the philosophical study of the nature of existence or reality, of being or becoming, as well as the basic categories of things that exist and their relations. It examines one underlying belief system as the researcher, about the nature of being and existence. It helps a researcher to conceptualize the form and nature of reality and what the researcher believes can be known about reality. The assumptions, concepts, or propositions help to orientate researchers' thinking about the research problem, its significance, and how the researcher might approach it to contribute to its solution (Kivunja & Kuyini, 2017). Since my study is a constructivist paradigm, therefore, I believe that there is no way we know absolute reality because our senses have a limited ability to know this reality. There is an experience and perceived knowledge constructed by individuals or groups that are influenced and shaped by society and social phenomena. Furthermore, the reality changes to individuals, social groups of people, places, and times. As my inquiry is about classroom discourse in mathematics, it may exist within the relationships between actors who participate in the discourse as a classroom phenomenon that constructs reality with their perception, abstract conceptualization, the language used, and its intended models. In my understanding, knowledge is the power by which all things are done and is concerned with the study of the origin, validity, and limits of knowledge, and this knowledge is generated through experiences and shared through modifications.

Epistemology is the theory of knowledge, which deals with the process of constructing and transforming knowledge and advocates the type of relationship between the knower and the known while constructing knowledge (Kivunja & Kuyini, 2017). In this sense, epistemology is the philosophical study of knowledge, which is worthwhile as long as the knowledge is valued (Korstjens& Moser, 2017). It illuminates the nature, sources, and limits of knowledge with a critical analysis of human understanding that reflects the view of what we can know about the world and how can we know it (Marsh & Furlong, 2002). As a constructivist researcher, my observation is always subjective and affected by social contexts and agents that relate to ontology. My epistemological underpinnings in this study are relational knowledge of discourse in mathematics classrooms with co-construction of meanings of mathematical objects and processes for the emancipation of the students' with shared roles in constructing, transforming, and transferring knowledge. Discourse as a constructive way of knowing and understanding mathematics in the classroom and outside can be generated through the process of active dialectic and dialogic role-play of participants. The mathematics classroom conversation and activities are the main sources of knowledge construction linked with existing pedagogical theories.

Axiological and Methodological Assumptions

Axiology is the branch of practical philosophy that studies the nature of value. Axologists study value in general rather than moral values specifically and often emphasize the plurality and diversity of values while at the same time adopting various forms of realism about values (Bahm, 1993). The principle of value or goodness represents the contribution of participants to the study. The axiological dimension considers goals, values, mission statements, objectives, beliefs, and opinions made of those being researched, as well as the interpretations made by the researcher (Kivunja & Kuyini, 2017). The study of the nature, types, and criteria that determine values and value judgments are crucial in the study. Creswell (2009) defines axiology as the science of values divided into ethics and behaviour and aesthetics, which deals with beauty. In education, axiology leads us to think about many evaluation questions, such as: What role do values play? What is the meaning of being a good person and a good citizen? What is beautiful and beautiful life? What is good and what is bad? Are values constant or do they change? (Gupta et al., 2022).

As a qualitative and constructivist researcher, my participants such as students, mathematics teachers, and head-teachers were the most valuable agents in the field because my study was based on their engagement, action, and communication. I appreciated each work of the participants to dig the reality out of their perceptions, experiences, and activities. Communication styles, pronunciation of words, the structure of sentences, body language changes, etc. helped me understand whether my participants were telling real facts or they were trying to exaggerate in front of me. Study location, weather, environment, and display board in the classroom also helped me to give some information about my study. Mathematical formulas, models, and theorems attached to the classroom display board provided me with an unspoken message about using mathematics and made it easy to understand that students were aware of mathematics. The school, the classroom, the school environment, the behaviour of the students, and the teacher provided me with information to compose an in-depth description and I valued them as contributors to me. In this study, I examined and valued perceptions, feelings, and attitudes of different cultural groups, head-teachers, administrative people in the schools, students, mathematics teachers, and mathematics educators. I interpreted and shared my experiences and learned the values, behaviours, beliefs, and language patterns of a group that shared culture and sought to understand human behaviour in my own social context.

Before conducting research, researchers must be sure about what they want to do and how to achieve their goals. The method is a scientific process by which a researcher systematically gains knowledge about a certain cause-and-effect issue. This is a very important part of the research. In the words of Anderson (1998, p. 93), a research method is an approach to investigating a research question. He further explains: Just as rain, snow, and small mountain streams mix and merge into a single body of water, similarly, multiple perspectives, different theoretical positions, and different processes of data collection, analysis, and interpretation are deeply and richly blended into a beautiful body of knowledge is "method". In this part, several things must be decided before the research is conducted. Decisions are made in advance as to which study sites and participants will be used and how data will be collected, analyzed, and interpreted. In this research, I have grouped my research methodology under the following subheadings, viz., research design, approach, study sites, participants, instruments and their description, data collection procedure, and analysis.

Research Design: Ethnography

A research design is a basic plan that guides the data collection and analysis phases of the research project. A research design can be considered as the structure of research. It is the "glue" that holds all the elements of the research project together (Akhtar, 2016). According to Crotty (1998), a research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy and procedures. Research design is the plan, structure, strategy, and investigation conceived to obtain ensured search questions and control variance (Kothari, 2010; Kumar, 2005). There are three types of research design namely qualitative, quantitative, and mixed-method (Creswell, 2009; Creswell & Creswell, 2018).

I used qualitative research design. Qualitative research uses the context and setting to search for a deeper understanding of the person being studied (Best & Kahn, 1999). This feature of qualitative research was carried out in the research process. The definition of the research design stresses systematic methodology in collecting the right information for interpretations with economy and procedures. The research design is a concept within which research is conducted. It is also the blueprint for the collection, measurement, analysis, and interpretation of data that is previously assumed. A research design should be more or less on some methodologies, and it should be made according to the topic and problem of research that guides the researcher throughout the research process. Qualitative research is a multimethod involving an interpretive, naturalistic approach to the subject matter (Acharya, 2017a). This means that qualitative researchers study the existing things in their natural setting, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them (Denzin & Lincoln, 2005). A qualitative design was chosen because a qualitative study uses inquiry to help, understand, and explain the meaning of social phenomena in the natural setting with as little disruption as possible. The classroom discourse is the ever-existing and real-time practice in our sociocultural contexts and only qualitative research can justify lively phenomenon.

Encrypted Ethnography as a Research Approach

There are different types of ethnographies such as auto-ethnography, engaged ethnography, institutional ethnography, medical ethnography, business ethnography, and educational ethnography according to the field of research. However, the main aim of ethnographic research is to explore the lively activities of people. Researchers working in ethnography add some prefixes to differentiate their work from others.

Some people have been engaged in the same job for years but they have not been able to identify their own performance. Either they are doing well or they are not. Are other people satisfied with their activities? Self-identifying own work is biased because everyone thinks that they are doing well. A fair judgment is made when one’s performance is viewed from others’ eyes. Here, someone’s work through others’ eyes which is hidden from the performers' eyes and feelings, I named it “encrypted”. I would like to convey an example that I encountered during the data collection process. I recorded a mathematics teacher's classroom discourse with his consent and then we sat down and watched it together. Looking at his own discourse, he said, I was speaking very fast and teaching in a hurry. If I taught like this, not only my students, but I myself would not understand. I did not know about it. None of the students said that I used to teach hurriedly. From now on, I will teach slowly.

Encrypted ethnography as a methodological approach is combinative, immersive, detailed, and contextual (Kivunja & Kuyini, 2017). It considers how people’s practices and interactions become immersed in their everyday routine to the extent that the actors themselves do not recognize them consciously (LeCompte, 1982). The ethnographic approach provides the benefit of combining data collected from in-situ observations and semi-structured interviews, participant observation, focus group discussion, and field note collection to understand those practices, interactions, and social behaviours (Geertz, 1977). For example, interviews can inform the observations and help participants reflect on their actions, which, in turn, helps the researcher understand the ways people interact in their workplace. Participant observation, interviews, and focus group discussions have been a hallmark of both anthropological and sociological studies (Angrosino, 2007). In recent years, the field of education has increased the number of qualitative studies that include participant observation as a way to collect information. Qualitative methods of information collection, such as interviewing, observation, focus group discussion, and document analysis, are included under the umbrella term of “ethnographic methods” in the research work.

Furthermore, Brewer (2000) defines ethnography as the study of people in naturally occurring settings or fields by methods of data collection that capture their social meanings and ordinary activities, involving the researcher participating directly in the setting, if not also the activities, to collect information systematically but without the meaning being imposed on them externally. Literally, ethnography is precisely writing about one's own sense of people’s livelihood. Ethnography is fieldwork research, which involves the study of real-life situations (Brewer, 2000, p.18). Therefore, field researchers observe the settings in which people live, and participate in their daily activities. It focuses on entire cultural groups (Creswell, 2003, p. 68).

As a teacher, I have understood the phenomenon so far and the ethnographic process was accurate in elaborating on social interactions, behaviours, and perceptions that occur within/with groups, teams, organizations, and communities. The central aim of ethnography is to provide rich, holistic insights into people’s views and actions, as well as nature (that is, sights and sounds) of the location they inhabit, through the collection of detailed observations and interviews (Iphofen, 2011). The task of ethnographers is to document the culture, perspectives, and practices, of the people in natural settings. The aim is to get inside the way each group of people sees the world. Ethnology involves the systematic comparison of different cultures using a range of ethnographic research methods to compare and contrast patterns within and between different classroom cultures (Iphofen, 2011). Ethnography is an important endeavor that serves as a tool for understanding diverse forms of living and experiencing the world. Ethnographic information collection is beneficial for meeting the cultural demands and needs of others. Ethnographic research tools, such as participant observation, focus group discussion, and unstructured interviews pertained to studying the teaching-learning cultures.

Selection of Study Site

Kathmandu Valley is the center of social, cultural, and political activities. Due to the migration of the people, the valley is a mixture of all cultural groups of people. My study was based on a cultural perspective and hence Kathmandu Valley was a suitable area to study the cultural pluralism exercised in the classrooms as the pedagogic activities. Therefore, I had chosen the study area as the Kathmandu Valley. I selected four high schools from this valley, which were fully funded by the government of Nepal. Before selecting the sample schools, I visited ten schools in the valley and indirectly talked to members of the administration about the students and mathematics teachers.

After receiving preliminary information, firstly, I chose only schools that gathered students from different parts of the country with different cultural, social, economic, religious, and linguistic backgrounds because my study was related to multiculturalism and the differences among students were fruitful for me. Secondly, I considered the number of mathematics teachers working in the school. I only selected schools with more than two mathematics teachers at the secondary level so that I would have no problem conducting focus group discussions among mathematics teachers. Finally, I also considered the schools where my acquaintances were working and could have easy access to gather information both formally and informally, engaged for a long time. I excluded those schools where students were admitted from the local level only because such institutions tended to have similar socioeconomic and linguistic backgrounds and fewer multicultural activities in the classroom would be exercised. Therefore, I have thought that the choice of places and organizations to collect information is appropriate. I have explained the complete details of the selected schools, locations, and environments in the data collection section.

Selection of Participants

Participants in a research study is the group of subjects having one or more characteristics in common with the focus of interest to the researcher, and to which the result of the study is intended to be applied. As the participants, students from the selected schools of Kathmandu Valley, their mathematics teachers, mathematics educators, and head-teachers were an essential part of my research inquiry.

A research participant is the representative part of an entire study (Levinson, 2010). A study site for Merriam (1998) is the selection of site, time, people, and events in the field. The participants in my study whom I selected for collecting information were my research units. The research participant in research could have a significant impact on the trustworthiness of the findings and so the process of deciding the choice of the participant is one of the crucial stages of the research process. Qualitative researchers usually work with only a few numbers of people nested in their context and study in-depth (Miles & Huberman, 1994). In the views of Patton (1990), there are no strict rules for research unit size in qualitative research and purposive sampling provides a researcher with the capacity to select participants relevant to the purpose of the study. These selected participants are referred to as "information-rich cases" that is "those from which one can learn a great deal about issues of central importance to the purpose of research" (Patton, 1990). The objectives of the researcher and the characteristics of the study participants determine which and how many people to select (Acharya, 2015).

There are three types of the most common sampling methods used in qualitative research and they are purposive sampling, quota sampling, and snowball sampling (Flick, 2009). Since my research study was qualitative, I employed qualitative sampling techniques. In this study, I used purposive sampling to obtain the right information from the participants. Simply saying, I selected my research participants purposefully to draw the required information. I also selected my interviewees in proportion to genders, ages, castes, religions, and cross-cultures so that I could collect the information to achieve the objectives of the study.

The classroom observation was taken from grade 6 to grade 10 because students in these grades can communicate with a teacher without any hesitation and express their feelings about mathematics learning through the discussion. This group of students can understand the culture of their society and classroom as well. Multicultural classrooms where students from different cultures, socio-cultural backgrounds, linguistics, gender, etc. were the main focus of the study shows a realistic picture of teaching-learning activities, discursive skills, and cultures taking place in Nepali schools. In my research study, I selected students, teachers, head-teachers, and mathematics educators as the research units. The participants were selected from the four community schools of Kathmandu Valley. I selected twelve mathematics teachers and four head-teachers from all four schools. I selected eight students from each school and altogether thirty-two students from all four schools. Similarly, four mathematics educators were also my participants. I selected these participants purposefully to collect the information and the information was collected iteratively up to saturation.

After visiting the selected schools, I interacted with teachers, head-teachers, and students for a few days, formally and informally, to establish rapport in the institution. Based on in-depth conversations with the individuals involved, I identified a cultural sharing group and their patterns of language and mathematics learning behaviours that have been together for an extended period of time may be multicultural in nature. With the support of the teaching and non-teaching staff of the schools, I was able to select participants who fulfilled the requirements of my study. I included students in my study to represent Tibeto-Burman, Indo-Aryan, and Newar-cultural groups. Some belonged to the marginalized society and some belonged to the mainstream of the society. As an ethnographer, I was conscious of mixing a variety of characteristics in my participants that addressed gender differences, multilingualism, religious diversity, age differences, oppressed groups, marginalized groups, and cognitive and ability differences.

In every school, I spent considerable time talking with participants and observing the learning activities of different cultural groups of students inside and outside the classroom. I intended to identify how they learned mathematical concepts, which concepts they found difficult, and which they found easy. I then selected culturally relevant issues to study about a group of students learning mathematics, including an analysis of culture-sharing groups. These included themes such as subjectivity, culture, learning experience, dominance, and inequality. I advocated and called for change and specific issues to explore such as inequality, dominance, oppression, and empowerment. I generated the participants' point of view (etic) from their perspective and my point of view (emic) to present the existing reality. Through all these selected participants, I tried to dig up the reality of the classroom discourse in a culturally diverse classroom in a naturalistic setting as much as possible. Then, I organized the various types of data obtained through observation, in-depth interviews, dyadic interviews, and focus group discussions. As a qualitative researcher working with an ethnographic approach, I began to collect a detailed description of a culture-sharing group and focused on a single event over several activities or in a group over a long period of time. Then I moved on to the topic of analysis.

Research Tools

Three information collection tools were used to obtain the required information to enrich the study as much as possible. These tools and techniques were useful to maintain the responsibility for the information. These tools were mainly, in-depth interview and dyadic interview guidelines, classroom observation guidelines, and focus group discussion guidelines as research tools in my research process. During the data collection process field notes, and audio and video records were also helpful for me in transcribing the information. I observed hundreds of mathematics classroom discourses to reach saturation and displayed sufficient classroom vignettes while analyzing information.

Classroom Observation Guidelines

Classroom observation was the pivotal tool in my study because "*classroom discourse*" occurs in the classroom and observation was the heart of the inquiry. As a tool of information collection, classroom observation has a long tradition in social science and it has been especially extensively employed by education researchers (Foster, 1996). It is the process of noting a phenomenon in the field to describe the events, behaviours, and artefacts in the social setting (Angrosino, 2007). An observation involves active looking, improving memory, informal interviewing, and writing detailed field situations. It provides an opportunity to check for non-verbal expressions of feelings and generate more creative approaches to leading voices to others.

The distinctive feature of observation as a research process is that it offers an investigator the opportunity to gather live information from naturally occurring social situations (Cohen, Manion, & Morrison, 2011). Robson (2002) pointed out that, what people do may differ from what they say, and observation provides a reality check. It enables a researcher to look at everyday behaviour because it is focused on facts and behaviour (Cooper & Schindler, 2001). The information which is obtained from the observations is useful for recording non-verbal behaviour in a natural setting (Bailey, 1994) and should enable the researcher to enter and understand what is being described (Patton, 1990). Classroom observations are important because the observer sees and gets first-hand information about the focused inquiry (Henning, Van Rensburg, & Smit, 2004). Erickson (1986) states that the “decisions the observer makes about the foci of attention in any one occasion of observation affect the completeness and analytical adequacy of observation made cumulatively across a set of trials” (p.30).

Realizing the significant contribution of observation in describing the real situation, observation was used as the first tool of information collection. To make effective observations, a classroom observation checklist was developed to ensure careful and systematic observation of teachers' and students' activities in the classroom. The observation checklist was particularly concerned with analyzing the gap between saying and doing and included the indicators related to multicultural education. The main rationale for using observation in this study was to assess how mathematics teachers respond to the individual needs of students in the classroom; what types of strategies they use to promote the learning of students; and how they manage different dimensions of multicultural education as well as to find the gap between knowing and doing. The observations were on what the mathematics teacher said and did, enabling me to make claims about mathematics discourse practice in a school mathematics classroom. Up to saturation hours of the mathematics classroom, observation of five consecutive lessons in one of each mathematics teacher was observed. Through, the use of these observations, I was able to find the type of interaction that exists between mathematics teachers and their students and how they relate to each other.

These classroom observations were video recorded and photographs were taken by the researcher himself with his own iPhone 6. Permission was sought first from the mathematics teacher and the students in the classroom to take photographs and video recordings. Some of the photographs were taken by the students of the related classrooms. I viewed the video records with frequent pauses and played and made important notes on my themes. The recorded video and audio were also shown to the related teachers and students so that they might improve their activities of action in the teaching-learning process. Observations were made on how students do mathematics, how they express themselves mathematically or communicatively, and how the teacher encourages students to participate in the mathematical and communicative discourse. Schensul, Schensul, and LeCompte (1999, p. 91) list the following reasons for using participant observation:

To identify and guide relationships with informants; to help the researcher understand how things are organized and prioritized, how people are interconnected, and what cultural norms are followed in the fields; to show the researcher what cultural members consider important in manners, leadership, politics, social interaction, and taboos; to help the researcher become familiar with cultural members, thus facilitating the facilitation of the research process; and to provide a source of questions for the researcher to address with the participants.

The suggestion of Schensul, Schensul, and LeCompte (1999) is very relevant to this study. From this suggestion, I knew that warm relationships with informants play an important role in gathering factual information other than what the guidelines for researchers point out. Researchers need to know how things are organized and prioritized. It is important to understand how people are connected to each other, and what cultural norms are followed in the regions. It is reasonable to be more conscious of what cultural members consider important in manners, leadership, social interaction, and taboos. It is easier for the researcher to proceed by becoming familiar with cultural members. Therefore, the researcher needs to know the basic criteria to motivate the participants, establish rapport with the cultural people, respect the language, religion, and behaviour of the participants and understand the environment of the study site.

Interview Guidelines

The second tool used in the research was the interview guideline (IG). The interview guideline is a widely used and useful instrument for collecting information that provides often an explanation of experiences in the qualitative information. The IG is such a research tool through which people are asked to respond to the same set of questions in a predetermined order. It aims to receive comparable answers from all participants (Flick, 2015). It was administered in the presence of the researcher and was comparatively straightforward to analyze.

However, forming the IG is one of the complex tasks as it requires practical skills to cover research questions under inquiry. Unreverent questions without appropriate words may lead to the wrong perception of the research participants. In making good quality IG, there is a simple rule of thumb, in the case of large participants the more structured, closed and short reply is appropriate but in the case of smaller participants, the less structured, more open, and word-based IG should be used (Cohen, Manion, & Morrison, 2011). Gillham (2000) advised that IG should be limited in length to answer the only required information, otherwise, the turn may be adversely affected. Based on questions, a pleasant environment should be created or developed. I interviewed my participants with unstructured and semi-structured questions which helped me to collect the information in the right way. Firstly, I employed the structured questions to a few participants to draw the information but later on, I felt as if unstructured and semi-structured questions' replies could be in-depth and change the plan.

Dyadic Interview Guidelines

When I visited two schools and tried to involve mathematics teachers in focus group discussions, I only found two mathematics teachers and conducted dyadic interviews instead of group discussions. Dyadic interviews are most useful when the researcher wants both social interaction and depth, when the narrative is valued, and when interaction in larger groups can be problematic (Bell & Campbell, 2014). Dyadic interviews are qualitatively different from individual interviews. They are more intimate than focus groups but still retain a slight sense of a public event (Morgan & Hoffman, 2018). The interaction and mediation that occurs between participants can lead to a mutual agreement on events and experiences, adding depth.

Although dyadic interviews only involve one more participant than individual interviews, the emphasis on interaction creates a much greater similarity to focus groups, necessitating a broader comparison between these two methods. Specifically, sharing allows each participant to expand on what the other has said, and comparison involves a process of differentiation that shifts the discussion in alternate directions. Taken together, sharing and comparing allow researchers to hear interesting similarities and differences in how participants think about the research topic (Morgan et al., 2013). This process of sharing and confrontation also occurs in dyadic interviews, when participants respond to each other. Dyadic interviews are very useful in interviews together with husband and wife, student and parent, and two teachers teaching the same subject.

Earlier, I had planned to conduct the focus group discussion and I had prepared the FGD guidelines but it was not as easy as expected when I went to work in the field. Two of the four selected schools had only two mathematics teachers. In such a situation, it was a problem to conduct the focus group due to the small number of participants. The ideal size of a focus group is 8-10 members, a facilitator, and a note-taker (Krueger & Casey, 2009). A dyadic interview refers to the exchange of information between two people with a note-taker (Legerstee, 2009). I conducted dyadic discussions with two mathematics teachers from the same schools in two schools each, which provided a better experience and feeling of classroom discourse in mathematics. The mathematics teachers of the same schools knew each other personally and had close relations, therefore, the information provided by them was reliable and exercised in the classroom discourse of mathematics. Each interview was conducted for one hour and I noted important issues in the discussion.

Focus Group Discussion Guidelines

Focus group discussions can present unexpected interactions, insights, ideas, and information about a phenomenon. Maykut and Morehouse (1994) argue that focus group discussions bring several different perspectives into contact to understand what people experience and perceive about the focus of inquiry, through a process that is open and emergent. In this study, the focus group discussions were used to explore the students' perceptions about the discourse practices that are used in their mathematics classrooms. Focus group discussion was aimed at understanding the perceptions and experiences of students about the mathematics classroom they observe daily. The focus group discussions helped to get the perceptions and understanding of mathematics teachers' experiences of their discourse practices during mathematics teaching to the students in multicultural classrooms.

The focus group discussions were conducted with the mathematics teachers of the selected schools and with selected students. From the focus group discussion, I got more information from the multiple participants which were very near to the reality of the experiences rather than personal in-depth interviews. In the personal interview, a single teacher/student put his/her personal views, perceptions, ideas, images, attitudes, and reflections but in the focus group discussion, more common themes were generated from the multiple views, perceptions, ideas, and images, attitudes, and reflections. In Sanskrit, it is said that "वादे वादे जायते तत्वबोधः" which means "*accurate knowledge (reality) is identified by the debate or discuss*". Therefore, it is easy to understand that focus group discussion is an important tool to extract reality from the multiple perspectives of the participants involved.

In School B and School D, I conducted four FGDs for students. Each school had student participation in two FGDs and conducted dyadic interviews for teachers. At School A, I conducted two focus group discussions for teachers. One FGD was attended by four mathematics teachers and one head-teacher, the other FGD was attended by mathematics teachers and three teachers of other subjects. In this school, I also conducted two FGDs for the students which were well attended by the students. In School C, I conducted one FGD for mathematics teachers including the head-teacher, and three FGDs for students. Teachers' FGDs included 4-7 participants while students' FGDs included 6-8 participants. Thus, I conducted 13 FGDs consisting of 4 FGDs for teachers and 9 FGDs for students. In the process of organizing FGDs, some teachers and students were repeated. Each FGD lasted from 30 minutes to an hour.

FGDs were organized around the main topics of pedagogical discourse in mathematics classrooms. The number of FGDs is shown in the following table.

Table 4. *The Collective Table of FGDs in Different Schools*

Schools	FGD for Teachers	FGD for Students	Dyadic Discussions
A	2	2	-
B	-	2	1
C	1	3	-
D	1	2	1

In these FGDs, I raised issues of how to engage students from different communities with different abilities. How teachers handle the classroom to create equity and equality. What is the attitude of students toward learning mathematics? Whether head-teachers are supportive in addressing physical facilities to conduct adequate classroom discourse. What were the opportunities and challenges of conducting classroom discourse in mathematics? How can teachers motivate and facilitate students? What methods are used in the classroom? What was the role of ICT in the mathematics classroom discourse? The FGDs of students were conducted on Saturdays, vacations, and after-school hours to minimize disruptions to learning as suggested by subject teachers and head-teachers. The focus group discussions were recorded on the cell phone and important notes were taken for the analytical study. The summative and collective table of participants, research tools, and objectivity of the research tools are given here.

Table 5. *The Collective Table of Research Tools*

Participants	Numbers	Research Tools Used
Students	32	Interviews (20 students)
		Focus group discussion
		(32 students)
Mathematics Teachers	12	Classroom observation
		Interviews
		Dyadic Interview
		Focus group discussion
Mathematics Educators	4	Interviews
Head-teachers	4	Interviews

Data Collection Methods Objective-wise / Question-wise

To gain the objectives of the study, the researcher utilized several methods of qualitative information collection in the context of the outlined classroom observation, semi-structured interviews, dyadic interviews, and focus group discussions (see Table 6) were conducted. The table below shows the three objectives and the connecting research questions followed by the bullets. Information collection strategies to fulfill the objective of the study are also displayed in the table.

Table 6. *Data Collection Methods by Research Objective/ Questions*

Q. N.	Research Objectives/ Questions	Data Collection Methods
1.	To explore the existing mathematics classroom discourse in school-level students. (How is the existing classroom discourse of mathematics teachers in the mathematics classroom?)	i) Classroom observations ii) Interviews with students and mathematics teachers iii) Dyadic interviews with mathematics teachers iv) Focus group discussions with students
2.	To investigate the engagement of students and teachers in conducting classroom discourse, in a culturally diverse classroom. (How do teachers engage themselves in promoting meaningful classroom discourse in the mathematics classroom?) (How do teachers motivate the students during the classroom discourse?)	i) Classroom observations ii) Interviews with students and mathematics teachers
3.	To explore the strategies for promoting student-friendly mathematics classroom discourse. (How can teachers make classroom discourse students-friendly, in a culturally diverse classroom?)	i) Classroom observations ii) Interviews with students and mathematics teachers iii) Dyadic interviews with mathematics teachers iv) Focus group discussions with students

4.	To explore the challenges experienced by mathematics teachers and students while conducting pedagogical discourse in mathematics. (How do teachers and students experience the challenges of engaging in mathematics classroom discourse?)	i) Interviews with mathematics teachers ii) Dyadic interviews with mathematics teachers iii) In-depth interviews with head-teachers iv) Interviews with mathematics educators

Data Collection Procedures

As mentioned earlier, different tools were used to collect the required information for the study. In this study, I recorded the videos of the classroom observations and audio recordings of interviews and focus group discussions. According to the previously prepared classroom observation guidelines, interview guidelines, and FGD guidelines, I observed 25 mathematics classrooms. In those observations, especially I focused on the mathematical problem-solving process, equitable classroom discourse, student participation, cultural integration in mathematical discourse, etc. The classroom observations from four community schools were recorded or notes were taken for further analysis. During the classroom discourse, if some particular cases of students were observed, such as un-participation, destructive behaviour, and student domination by the teacher, etc., I selected them for in-depth interviews and FGD. I requested all the mathematics teachers and head-teachers from the selected schools for personal interviews for further information on their experiences, perceptions, and preparation for the innovations. I recorded in-depth interviews on my cell phone for further analysis of the information. After the collection of information, I carefully analyzed and interpreted extracting the main theme of the information.

Gaining Access in the Field

Gaining access to the study site and finding willing participants is a straightforward process in ethnographic research. To deal with practical realities and the often-unforeseen challenges of the particular research, researchers have to apply their classroom and experiential knowledge, develop a range of research skills, and learn new attitudes. Gaining access is not easy work it is somehow critical. The success of information gathering depends directly on how easy or difficult it is to access the study site and how well the researcher can build and maintain relationships with the participants and hold them to agreements. Gaining access using four stages: pre-entry, during fieldwork, after fieldwork, and getting back (Kostić, 2020) is essential in the field of social research. In the pre-entry phase, I employed formal ways of communication (e.g., online directory, formal telephone calls, emails, cover letter with official letterhead), fixed appointments based on interviewees' availability, and ensured confidentiality.

During the fieldwork, I tried to adapt to the cultural norms of the research site using formal dress, might need to address interviewees formally using surnames, taking permission to photograph, video record, and voice record, respecting the culture and language ascent, and building a strong rapport. After the fieldwork, I send a formal "*thank-you*" note immediately from the SMS of the cellphone, keeping the necessary relationship for a further lifetime. Finally, I got back with warm relations with participants, taking their email addresses and connecting with social media.

Data Analysis Procedure

Data analysis is the central step in qualitative research. Qualitative information analysis is the classification and interpretation of linguistic or visual material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it (Flick, 2013). Meaning-making can refer to subjective or social meaning. Qualitative data analysis is also applied to discover and describe issues in the field of structures and processes in routines and practices (Anderson, 1998). From a similar standpoint, Best and Kahn (1999) suggest the first step in analyzing qualitative information involves organizing information.

Descriptive research involves collecting information to answer the questions about the current status of the subject of the study (Gay, 2000). It describes the conditions or relationships that exist, opinions that are held, processes that are going on, evident effects, or trends that are developing (Singh, 2012) in the field of research. Furthermore, Flick (2009, 2013) describes qualitative data analysis as the classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it. Meaning-making can refer to subjective or social meanings. Qualitative data analysis is applied to discover and describe issues in the field of structures and processes in routines and practices. The final aim is often to arrive at generalizable statements by comparing various materials or various texts or several cases.

There are several methods of qualitative data analysis according to the nature of the information collected in the field (Belotto, 2018; Warren, 2020) (e.g., Qualitative content analysis, Narrative analysis, Discourse analysis, Thematic analysis, Grounded theory, Interpretive phenomenological analysis, etc.). Among these data analysis methods, thematic analysis and grounded theory are two, that fit in the ethnographic study (Bailey, 2018), and therefore, I adopted the thematic analysis (Braun & Clarke, 2006; Clarke & Braun, 2013), which was very suitable to analysis the different sources of information like personal interviews, focus group discussions, audio-visual information, field notes, photographs, and document analysis. The first step of data analysis was transcribing the audio-video information by listening and watching several times. Then, I triangulated the information obtained from different sources such as interviews, classroom observation, and focus group discussions. After the triangulation of the information, I employed coding, categorizing, and making themes.

Thematic Analysis Procedures

Thematic analysis (Braun & Clarke, 2006) is a powerful method of information analysis (Braun, Clarke, & Weate, 2016; Lochmiller, 2021) that allowed me to summarize, highlight key features, and interpret a wide variety of information sets. Most importantly, the thematic analysis offered me great flexibility concerning (a) the type of research questions it can address, personal accounts of experiences and understandings of people with broader concepts in various social contexts; (b) the type of information and documents examined; (c) the volume of data analyzed; (d) the choice of the theoretical and/or epistemological framework applied; and (e) the ability to analyze data with an inductive, information-driven or deductive, theory-driven approach (Clarke & Braun, 2013; Kiger & Varpio, 2020). Thematic analysis of data adopts six phases (Nowell et al., 2017) while generating meaningful and core themes in the study from the start to its completion. During the thematic analysis, I listened to and transcribed the raw data several times. I then highlighted important words, phrases, and sentences that provided the central idea of what information the participants wanted to reveal. I made different meaningful phrases from the information exposed and chose the best one that reflected the whole information.

Table 7. *Thematic Analysis Steps*

Phases of Analysis	**Process of Analysis**	**What did I do?**
Phase I	Familiarizing with data	Long engaged with participants Triangulated different information-gathering modes Recorded theoretical and reflective thoughts Documented ideas about possible codes Codes were compared with and within different interviews and FGDs Stored raw information in well-organized archives All information was recorded in field notes, transcripts, and reflexive journals
Phase II	Generating initial codes	A peer debriefing was conducted Reflexive Journaling was scanned Used coding frameworks Audit trail of code production Documented all team meetings and peer debriefings
Phase III	Searching for themes	constructed diagrams to make sense of the theme connections Made detailed comments on the development and hierarchy of concepts and themes
Phase IV	Reviewing theme	Themes and sub-themes were reviewed Citations and references were tested for adequacy by returning to the raw data

Phase V	Defining and naming themes	Peer debriefing conducted Team consensus on themes was taken Documentation of team meetings regarding themes was done
Phase VI	Producing the report	Documentation of themes was carefully done member checking was done Peer debriefing was done Described the process of coding and analysis with sufficient details A thick description of the reference was created Described the audit trail A report on the rationale for theoretical, methodological, and analytical choices throughout the study was made

I have described my detailed engagement with participants in the field and the handling of data obtained from three modes (classroom observation, in-depth interviews, FGDs) of data collection.

Generating Codes and Themes

In the first phase of thematic analysis, I was fully engaged in the field with my participants in four community schools. I spent my one year time, visiting four schools selecting participants in the schools, and engaging them in interviews and FGDs. Before conducting personal interviews, dyadic interviews, and focus group discussions, I observed the classroom discourse of the respective participants. Prolonged engagement with participants produced rich insights and information into my field of study. All the information was carefully noted or recorded for further analysis. Then, I transcribed and triangulated information gathered from three modes. Based on the collected information integrated with my experience and reflection, I prepared the lists of theoretical and reflective thoughts. From the triangulated information, it produced ideas about possible codes. I made hundreds of possible codes. I compared these codes with one interview to the next interviews of students, teachers, head-teachers, and mathematics educators. It was not less challenging for me to compare the codes generated from classroom observations, interviews, and FGDs and to make an appropriate selection of codes among piles of possible codes. It took me about six months to select appropriate codes from the huge jumble of information obtained from the field. I have tried my best to provide justice to the information collected through all three modes and link them with relevant references from books and journals. During the creation of codes and themes, I periodically consulted with my research supervisor, my colleagues, and mathematics teachers. During the process, I reflexively scanned and visited relevant journals to learn more about the study. I prepared member checklists and sent my writing back to my respective participating teachers and also addressed suggestions for suitability. The small section of thematic analysis of data is shown in Appendix- xi.

Ensuring Trustworthiness

Maintaining quality standards in qualitative research is one of the difficult and essential parts of the study. Lincoln and Guba (1985) described four general types of trustworthiness in qualitative research: credibility, transferability, dependability, and confirmability whereas Korstjens and Moser (2018, p. 2), announced five types of quality criteria for all qualitative research and they are credibility, transferability, dependability, authenticity, and confirmability. I have mentioned the five main criteria of quality standards and how I have maintained them in my research is described below.

Credibility. Credibility refers to the confidence that can be placed in the truth of the research findings. Credibility establishes whether the research findings represent plausible information drawn from the participants' original information and is a correct interpretation of the participants' original views (Korstjens & Moser, 2018). It is equivalent to internal cogency in quantitative research and is concerned with the aspect of truth value.

I have maintained credibility in my study by investing a long time with the participants to build trust and get real information. I spent almost two years in the four schools observing classroom teaching, students' interviews, students' focus group discussions, and teachers' interviews. I have told to all the participants about my research process to make them familiar with my research objectives and the context. I have triangulated the information collection collected using multiple methods like in-depth interviews, classroom observations, and focus group discussions.

Transferability. According to Korstjens and Moser (2018), transferability is the degree to which qualitative research results can be transferred to other contexts or settings with other participants. The researcher facilitates the transferability judgment by a potential user through the thick description. Transferability concerns the aspect of applicability. A researcher's responsibility is to provide a 'thick description' of the participants and the research process to enable the reader to assess whether our findings are transferable to their setting.

I provided a rich account of descriptive information, such as the context in which the research was carried out, set participant's background, qualifications, and teaching experience in the case of teachers, description of location and timeframe, and in-depth interview procedure in detail to maintain transferability.

Dependability. Dependability is the stability of findings over time. Dependability includes the aspect of consistency. Dependability involves participants' evaluation of the findings, interpretation, and recommendations of the study such that all are supported by the information received from participants of the study (Korstjens & Moser, 2018). The interpretation is based on the particular preferences and perspectives of the participants rather than my perspective. It is based on real information obtained from the participant's in-depth interview, focus group discussion, and classroom observation.

To maintain dependability, I have mailed the methodologies and the information analysis parts of my study to the participants to review and give feedback. All the participants became interested to see my work and returned within one week with feedback. I have included the feedback on the analysis part of my study.

Authenticity. An important issue for qualitative research is authenticity which concerns about the responsibility and cogency of the research that is worthwhile and its impact on members of the culture or community being researched**.** Authenticity involves an assessment of the meaningfulness and usefulness of interactive inquiry processes and the social change that results from these processes (Shannon & Hambacher, 2015). Authenticity in qualitative research represents a fair range of different perspectives on different topics. It is also a community consensus that the findings should be useful and meaningful, especially meaning for action and further steps (Flick, 2017). With member checking, participants or other members of the community exploration can sometimes be questioned about what is known as end-users.

I maintained the authenticity by following the strict member-checking process followed by the participants (students and mathematics teachers) ideally taken from randomization and all were to provide unique information about the issues to be researched. Member checking ensured participants' validation and was done to improve the trustworthiness. I transcribed the interview data, printed them, and showed them to the respective participants for confirmation which helped me to ensure the accuracy of the data before analysis. I was keenly aware that not everyone could articulate what they were trying to say and could be misunderstood. The member-checking process helped me to minimize the misunderstandings in the data collection process and re-correct them. Fully informed consent was taken that they were researched and would be part of the research, caring and trusting relationships were nurtured, and inquiry procedures were rendered transparent to all participants and audiences. I also created participant inquiry collaboration into every step, with full agreement on the rules to govern the inquiry, and provided the full information of their voices, meaning, and results. I provided the inquiry report to every respondent and audience and made rearrangements if they were against what I had drafted. Therefore, a clear mechanism was established in cases of conflict or disagreement of participants' saying and doing during the study.

Confirmability. Confirmability indicates the degree to which other researchers could confirm the findings of the research study. Korstjens and Moser (2018) state that confirmability is concerned with establishing that information and interpretations of the findings are not figments of the inquirer's imagination but derived from the information. It concerns the aspect of neutrality. Confirmability is the last criterion of trustworthiness that a qualitative researcher must establish. This criterion has to do with confidence that the research study's findings are based on the participants' narratives and words rather than potential researcher biases.

I have tried to maintain confirmability by following its main criteria of triangulation, reflexivity, and replication of data. I have mentioned the research procedure in detail. As a qualitative researcher, I have looked at my background and position to see how these influence the research process (i.e., selecting the topic, choosing the methodology, analyzing the information, interpreting the results, and presenting the conclusions). The analysis and interpretation part is based on the actual view of the participants as I have maintained myself to be a biased-free researcher. As a member of the same demographic group and profession, I have my own experiences and opinions but they have not affected the perspectives of participants from different schools.

Ethical Considerations

Before the information collection process began, I knew that participants in the research had the right to be informed that they were being expected to see what they do in reality and about the nature of the research. Therefore, I respected their rights by ensuring that I got permission from the concerned authorities and informed the participants of what the research would be all about. I selected only those teaching institutions (schools) that permitted me to do the research process. I respected the selected institutions and participants' reality, and situations and did not disclose their secrecy to others, such as participants' misbehaviour, emotional talk, and misunderstanding towards the head-teacher. I respected the culture, language, social scent, and backgrounds of all the participants. In some cases, I got written/oral permission from parents to involve their offspring in the research process and also granted permission from their head-teacher. To ensure that the information gathered would be of high quality, I needed to protect the participants' identities. I assured participants' confidentiality.

According to Rallis and Rossman (2003), confidentiality has two elements, protecting the privacy (identities, names, and specific roles) of the participants and holding in confidence what they share with you. Bulmer (1982) says that to protect the privacy and the identity of the research participants, locations of individuals and places are concealed in published results, information collected is held in an anonymous form and all information is kept secure and confidential. In all my research, publications, and writing, I assured all the participants and those in leadership positions that no real names and locations would be used unless the participants and the schools permitted me to do so. Apart from protecting their identities, I also ensured that what they told me would remain confidential. In the thesis and any published work, pseudonyms would be used to protect the identities of the participants. I was assured to destroy all the voice records, video records, and photoshoots immediately as soon as my research was completed to protect the participants' privacy, identities, and confidentiality.

Rhetorical Assumptions

The rhetorical assumption is the process of using language, style, and communications formally and effectively, especially as a way to persuade or influence people. In my research, I used the first-person language (I, my, me) as I was doing the key function in this research. I did not use dual-meaning words that confuse the readers. I used clear, concise, and grammatically correct sentences in the research writing as much as possible from my side. All the citations were in APA format to create uniformity. I acknowledged all the scholars in their scholarly work as I found them useful in my research process.

Chapter Summary

In this chapter, I presented my research paradigm which clarifies my approach to the ontological, epistemological, and methodological underpinnings of the research. I have adopted the ethnographical study in which the selection of the study site, the participants, and the research tools are clearly and logically mentioned which would be sufficient to guide this study and lead to the achievement of the objectives of the research. I have conceptualized information collection procedures, data analysis methods, trustworthiness, ethical issues, and rhetorical assumptions in the study of the subsequent processes are also presented in an exploratory way. I thought this chapter would probably outline the roadmap of the study destination.

CHAPTER IV

PRACTICES OF EXISTING MATHEMATICS CLASSROOM DISCOURSE

This chapter dealt with finding the answer to the first research question that I set the question was "How is the existing classroom discourse of mathematics teachers in the multicultural classroom?" This research question was related to my first objective, which was, to explore the existing mathematics classroom discourse among school-level students in a multicultural classroom. For this, I tried to enlighten the phenomenon of dialogue and dialogical teaching to examine dialogue as a means of learning through mathematics classroom discourse analysis. For this goal, I selected four public schools in the central part of Kathmandu city, where students with diverse backgrounds from 77 districts were gathered in the same arena. Here, I collected the information from four schools, namely School A, School B, School C, and School D. This chapter is the overview of the analysis and interpretation of collected information organized from 32 students, 8 mathematics teachers, 4 mathematics educators and 4 head-teachers recurring in-depth interviews; 16 Classroom discourse of mathematics observations, 4 dyadic interviews of teachers, 20 in-depth interviews, 4 FDGs for teachers, and 9 FGDs for 32 students.

All the strategies of information collected from classroom discourse observation, in-depth interviews, and FGDs consist of dialogic interactions. With time educators and researchers (Alexander, 2005; Duchak, 2014; Zhang, 2008) have adopted the dialogic method, and argued that dialogue must be built upon participants' understanding of existential realities, lived experiences, personal struggles, engaged practices, and possibilities. In this context, classroom talk is supposed to be the most pervasive in its usefulness and powerful in its possibilities.

Especially, it seems to be valuable in the school environment where a large proportion of time is spent talking and listening in the process of transferring knowledge to the learners. Dialogue is a form of talk, which is widely used as a teaching tool at school. Through dialogue, people are engaged in the practice of listening to different perspectives, promoting cooperation, building skills, and working on difficult issues. The most crucial consideration within dialogic pedagogy is the quality of communication. Moreover, the participation of pupils in the construction of their knowledge includes a motivational factor that deals with the activation of pupils (Zhang, 2008). Dialogic teaching is extremely significant, and especially necessary for pupils in the classroom as it is an effective method to listen, understand other people's views, and cognize pupils' reflections about the world. Besides, the aim of the dialogue is not to find truth but to explore more possibilities, and to stimulate further analysis. According to Alexander (2005), dialogic classroom discourse includes four repertories: teaching talk, learning talk, talk for everyday life, and classroom organization.

Classroom Discourse from School A

School A which, I selected for the research was located at Maharajganj on the right way from the prime minister-quarter (Baluwatar) to the president's residence (Shital Niwas). It was established in 2005 BS. This school had classes from nursery to class twelve. I went to this school on 3rd November 2019, for the first time. The school has three main buildings with the shape of the English alphabet 'C'. They were connected to each other. As I entered the school grounds, the gatekeeper asked for my introduction and the reason for being there. I replied that I wanted to meet the head-teacher of this school. The gatekeeper told me to go to room number 5. The school was decorated with many green bushes and flowers at the corners of each side. When

I entered the head-teacher’s cabin, he was busy on the telephone. He told me to sit on the sofa which was nearby him. I clarified to him about the reason for my visit to the school. He accepted my request happily and told me that he would help me as much as possible from his side. He offered me a cup of tea. We talked for half an hour about the school. We had an interesting conversation in a peaceful environment. Then he said, "*Sir, you're a little late today. Come tomorrow at 11 o'clock. I'll make you meet with the mathematics teachers.*" The next day I reached the school premises at 10:45 AM. The head-teacher was in his cabin. He gave me a school magazine. We went to the teachers’ room where 10-15 teachers were seen busy with their school work. The head-teacher introduced me to all the teachers and told them why I was there. Then he asked three mathematics teachers to come to a separate room. We had a fruitful conversation about the school, students, and social status of students. The social status of students refers to the level of respect and recognition they receive from their peers and the wider community. It is based on factors such as academic performance, wealth, family background, and extracurricular activities. The mathematics teachers and I exchanged our cell phone numbers. They shared their class timetable and yearly plan. I had also seen a yearly master plan at the head-teacher’s cabin. The mathematics teachers informed me that from the next day, according to their plan, I could observe the class whenever I felt comfortable.

Although I had observed ten mathematics classroom discourses of this school to explore the existing mathematics teaching trend, only six observations were used to collect the information. I did not collect the information from the first observations of each class because the students in the first observation could behave carefully and I felt that they controlled themselves before me. In such a situation, the appropriate information could not be collected in the natural setting. Especially, I especially explored the classroom discourse of three teachers Raj, Nayantara, and Sanjog (pseudonyms) from School A as they all were experienced and handling multicultural classrooms in a natural setting. Before the observation of classes, I had talked with each teacher about my aim of observation, and I also requested them to handle the classroom as usual without exaggeration. I believed that each teacher was qualified, experienced, and trained. Here, I am going to explain one of the classes of Raj which was observed on the 24th of November 2019, in class six. As Raj and I were about to go to the classroom, Raj had a long sliding number line device made of a piece of wood, a whiteboard marker, a duster, and a mathematics book written in English medium. The school was fully funded by the government of Nepal. The school strictly followed the mathematics textbook issued by the CDC, Nepal for more than seven decades from its establishment, but as the number of boarding schools increased in the locality, and many students and parents preferred teaching and learning in an English medium, the school adopted mathematics textbooks in the English language from private publication. The information from classroom observations is first presented as a classroom vignette, then interpreted meaningfully and finally discussed with the link of related literature and theories.

Classroom Vignette 1: Teaching of Real Number

Students of class 7 were divided into two sections (Section A and Section B). Section A had 52 students from different districts with vast diversity in terms of language, culture, gender, cognitive, and sociocultural backgrounds. There were 21 boys and 31 girls in the classroom. Students were arranged on 17 benches. Boys and girls were seated separately. They had enough space for teaching-learning activities. A big whiteboard was on the front side of the wall. While the teacher and I entered the classroom, the classroom discourse was as follows.

Students: *Good afternoon! Sir.*

Teacher: *Good afternoon students! Thank you. Sit down.*

Teacher: *How are you, students?*

Students: *We are fine, sir.*

Teacher: *Well. Students, we have BB sir today and he wants to observe our class. Let us welcome him and let him sit here* (showing one bench).

Students: *Of course. Okay, sir.*

The teacher wrote the date on the upper left corner of the whiteboard, and the chapter title on the top middle of the board.

Teacher. *Do you remember what we studied yesterday?*

Students: *Yes sir, we studied real numbers and we also made a sliding scale to calculate real numbers.* (Many of them had slide scales made of hard paper by themselves).

Teacher: *Today, I will teach you how to add and subtract real numbers by using this* (showing a teacher-made device) *device.*

Students: *It's okay sir.*

Teacher: [Wrote a problem on the whiteboard as, -5 +4 -2, each time uttering, as minus two, plus 4, minus 2.] *How much is the answer? Can you solve it?*

Students: Hurried to slide their paper device.

S_1: *Sir, -3. [Minus 3 comes].*

S_2: *-3. [Minus 3].*

S_3, S_4, S_5... S_{46}: *Sir, -3. [Yes, yes, yes sir. Yes, minus 3].* [Choral expressions at the same time]

Teacher: [Took a student who made a paper slide device and went to the whiteboard, showing the device.] *What do we do first? We arrange the lower zero and upper zero* *together and take -5 and +4 parts only and it is -1. Again -1 and -2 are added together, which is 3. But we should put the minus sign before 3 because both the numbers 1 and 2 are in minus.*

$$-5 + 4 - 2$$
$$= -1 - 2$$
$$= -3$$

Teacher: *Thus, we can do this and this type of problem(s), with the help of this* (showing slide device) *device given in the exercise book.*

Students: [Silent.]

Teacher: *Again, we should arrange this -1 and -2 and it is -3, is that ok? You did the same way or not?*

Students: *Yes, yes…, yes sir.* [Choral sound]

S5: *Now, sir call us one by one there on the board. We do it on the whiteboard. Okay, sir*.

Teacher: *Okay*. [Wrote a similar type of problem on the board.]

$$-7 + 5 - 6$$

S_1, S_5…, and S15*: I will do it. I also do. Sir, I will do it.* [Choral voices raising their hands]

Teacher: *Okay*. *Okay, you come.* [Showing a girl with a hand]

S_{12}: [The girl, to whom the teacher indicated, confidently came on the board. She calculated by using the device and on the board too.] *Sir, its answer is -8. [Minus 8.]*

Teacher: *Is that right?* [Asked for all the students.]

Students: *Right. Yes sir, right.*

Teacher: *Yes, she is right. Let us clap for her.*

Students: Everybody clapped.

Similarly, the teacher wrote other problems one by one. All students were ready to solve the problem. Students spontaneously and actively participated in learning activities. But, one of the boys solved the problem in the following way.

$$4 - 3 + 2$$

$$= 4 - 5$$

$$= 1$$

The next boy: *Wrong. Wrong. This is wrong.*

By showing this solved problem on the board to all the students, the teacher asked them.

Teacher: *Is that correct?*

Students: *No. He made a mistake.*

Teacher: *You come here, Binita.*

Binita quickly went to the whiteboard near the teacher.

Teacher: *How many mistakes are there in this solved problem?*

Binita: *Um…. There are two mistakes.*

Teacher*: Can you make the corrections?*

Binita: *Yes sir. I can do it.*

Teacher: *Okay. Work on it.*

Binita solved the problem in the following way.

$$4 - 3 + 2$$

$$= 4 + 2 - 3$$

$$= 6 - 3$$

$$= 3$$

Teacher: *Yeah. She is right. All of you clap for her.*

Students: [Choral Clapped]

Teacher: *Now you understand. We always add plus terms by putting them together and again add all the minus terms by putting them together and putting the minus sign before the number and finally subtracting the smaller term from the bigger term. The sign is used for the bigger term. And, the correct solution to this problem is;*

$$4 - 3 + 2$$

$$= (4 + 2) - 3$$

$$= 6 - 3$$

$$= 3$$

Students: *Yes sir. We understand now.*

The teacher wrote 5 problems on the whiteboard.

Teacher: *This is your home assignment. All of you try to do this.*

In this way, the class ended. The class activity began with a review of the previously taught contexts and gradually the teacher moved to the problem-solving method along with full conversations among the students. The teacher wrote the problem on the whiteboard for the students to solve. Many of the students had no idea how to solve the problem. Then the teacher taught the method of solving the problem step by step, exchanging ideas between the teacher and students. After solving the problem, the teacher gave a similar type of problem to the students and they easily solved it. A few students were unable to solve it and a few students solved it while making some mistakes. Especially those students who were passively sitting just listening to the teacher could not solve the problem or could solve it partially. The teacher corrected the mistakes made by the students and suggested some useful tips to solve the problem appropriately. The students actively participated in the classroom activities. The collaboration and cooperation of students were seen while solving the problem. I did not notice any written documents and teaching materials made by a teacher like a lesson plan, number charts, or teacher's guide that could be supportive in the classroom discourse. I was interested in observing one more class about the same chapter. I requested the subject teacher. He quickly accepted my request. I observed the next class about teaching real numbers in class 7A on 25th November 2019.

Classroom Vignette 2: Teaching of Real Number

When we entered the classroom every student stood up in their right place and greeted us and we also greeted them back. Then, I sat on the last bench where one student was sitting. I asked him to sit on the next bench where two more students were sitting.

Teacher: *I think, you had homework yesterday. How many of you have done it?*

Almost all the students raised their hands and said that they had done the home assignment but two girls and a boy had not completed the home assignment.

One girl: *Sir, I was absent yesterday due to a severe headache. So, I could not do the homework. I did not know about the homework.*

Next girl: *Me too, sir. I had an appointment with the dentist at 11:30 AM yesterday and my mother suggested me not go to school. Therefore, I could not come to school and I did not do the homework.*

Boy: *Sir, I had done homework but I left the homework notebook at home, by mistake.*

The teacher advised them to be punctual in the classroom as much as possible.

Teacher: *Those who have not done the homework today, you must complete it the next day.*

All the absent students agreed with the teacher and the teacher checked the homework of the others thoroughly, desk by desk, and suggested the students make corrections accordingly. Students made the corrections.

Teacher: *Today, I am going to teach you to solve real numbers by using the real number line. With the help of a real number line, you can easily find the solution to the given problems.*

Then the teacher drew a straight line and divided it into 20 equal parts with the help of a long wooden ruler and explained his best. He wrote on the whiteboard and elaborated.

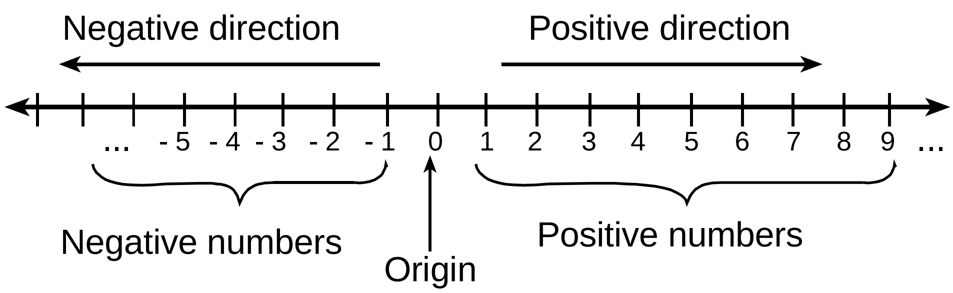


Figure 3. Detailed Real Number Lines

The central part of the real number line was zero and rightwards positive numbers go on increasing which is called positive direction. On the left-hand side or leftwards from the zero mark negative numbers go on increasing which is called the negative direction. Further, he defined the real number line as ‘A real number line is a straight horizontal line divided into equal intervals that include infinitely many integral values. Some of the students copied on their exercise books and others just listened. One of the girls stood up and asked.

Girl: *Sir, What is this ‘horizontal’ and ‘infinitely’?*

Teacher: *How many of you know the meaning of ‘horizontal’ and ‘infinitely’?*

A girl: *Horizontal means ‘left to right and infinitely means ‘very big’.*

Next girl: *Infinitely is ‘a large number’.*

A boy: *Infinitely is ‘an uncountable number’.*

Next boy: *Infinite is a large value.*

After listening to the views of all the students, the teacher wrote on the whiteboard all the meanings that students replied to and underlined the terms.

<u>Very big</u> <u>A large number</u>

<u>Uncountable number</u> <u>A large value</u>

Teacher: *You all are correct. Whatever you said 'Very big, a large number, Uncountable number, a large value. All the terms have a similar meaning and it is a number greater than any assignable quantity or countable number. In mathematics, it is written in a symbol ∞. That is, ∞ (infinity).*

The teacher wanted to tell the students, that the symbol ∞ is read as infinity.

Similarly, the teacher explained the meaning of 'horizontal' as a straight line passing left to right. Then he wrote a problem concerning real numbers.

$7 - 9 - 2 + 5$

Teacher: *Are you all looking at this problem? I think you know how to solve it, Isn't it?*

Students: *Yes sir, yes it is.*

Teacher: *But, today; I will teach you a new way to solve it with the help of this real number line and it is a very easy method of solving real number problems. Everyone, please look carefully. Pay your attention to the board.*

Students: [Silent.]

Teacher: *First of all you must draw a real number line with the help of a ruler. Has everyone got it?* [Teacher drew a straight horizontal line almost at the middle of the whiteboard.]

Students: *Yes sir. We understood it.* [Showing rulers on their hands.]

Teacher: *Divide this line into 20 equal parts like this. Here, I divide approximately but you should use your ruler. You may adjust these parts according to the question. See here, the biggest number is 9. So, you must divide the line up to 9 or 10 on one side and the same on the next side.* [Teacher divided the horizontal line into 20 equal parts.]

Students also did the same in accord with the teacher. Some of the students were seen facing trouble in dividing the horizontal line into equal parts as shown. They were asking their friends for help. Some of the students did not have a ruler and they were using their friend's ruler.

A boy: *How to make equal parts?* [Whispered to the next boy.]

Next boy: [Grasped his exercise book and made the divisions by suing ruler]. *See, you do like this.*

Teacher: *What is the first number, here?*

Students: *7.*

Teacher: *Yes, 7. So, put a small dot (.) at 7. But it is +7. Make it on +7. And then there is -9. Move towards the left (negative direction) of 9 steps from +7. Now, you have reached -2. Again there is -2. Move leftwards for 2 steps and you get -4. Now, finally, you have +5 and you should move 5 steps rightwards (positive direction). Finally, you get +1. Therefore, the solution to this problem is 1.*

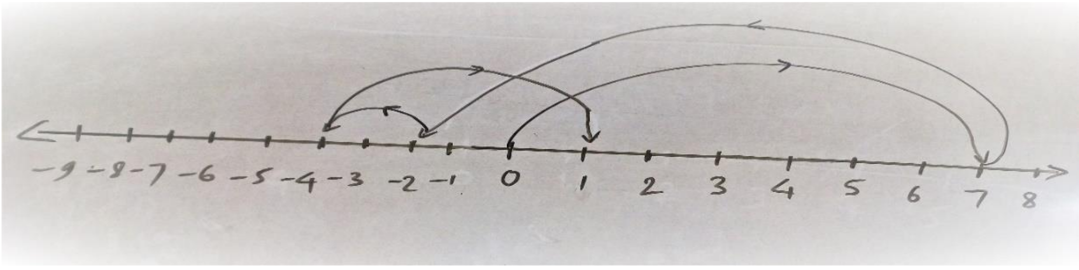


Figure 4. Problem-solving from a Real Number Line [Field Photograph]

The teacher repeated the same thing three times. He wrote a few more examples on the board and repeatedly explained the whole process. After that, he wrote problems on the board and asked every student to solve them on the board one after another. The students were interested in learning and were hoping that their teacher would call them to solve them on the whiteboard. The teacher taught simple to complex problems to his students. To make the concept clear, he added sufficient relative examples that exist in real practice, for example, “You remember, plus as your friend gives you something, and minus as you give to your friend”. The difference is your final answer. As the teacher thought that the students had a clear concept, he opened his book and asked the students to open their books too, on page number 67. Students hurriedly opened their textbooks.

One of the girls stood up, and said: “*Sir, I missed my mathematics book at home while doing homework this morning”*. Raj advised her to share her friend’s book and not to miss the book at home again. Raj assigned a few classwork problems. Almost all the students confidently did the classwork quickly and silently. As they finished their classwork they stood at their place and asked their teacher to check whether they were right or not. I noted that a few of the students had some problems solving the given question and they copied from their friends. The teacher also noticed that some students had problems and were copying from their friends. He made them aware that they should not copy from their friends without understanding.

The teacher told the students to ask him rather than copy from their classmates. Again, Raj wrote some questions on the whiteboard, which students found difficult. He assigned some questions for homework to the students.

In my observation, I came to know that the school had adopted an English medium mathematics textbook from a private publication, which costs much for students studying in the community school. Although the Government of Nepal has distributed all the textbooks free of cost for the students enrolled in the community schools, community-based schools like School A has used English medium mathematics textbooks to fulfill the demands of parents, students, and schools as well. In the entire classroom, neither the teacher used the English language nor the students. Teachers and students communicated verbally in the Nepali language but they wrote in the English language. Especially, students from Chhetry[4] and Brahman communities, use the Nepali language as a home language and school language for communication, and the English language as a mathematics learning language. However, some students from Magar, Rai, Limbu, Tamang, and Newar communities use their family language at home, Nepali as the school communication language, and English as their mathematics learning language.

The classroom was fully decorated with useful learning materials for different subjects but I noticed that only a piece of paper was paved with mathematical formulae. This activity illustrated that mathematics is rarely used in the free expression of students. From the above information, I generated the following theme and interpreted it.

[4] There are four major caste categories in Nepal. They are Brahaman, chhetri (kshetri), Vaishya and shudra. These major categories include more than 123 sub-categories.

Teachers Adopted Interactive Teaching Method

In my two classroom observations, I found that teachers adopted interactive teaching methods. Interactive teaching is a teaching pedagogies where teachers actively involve students in their learning process through regular teacher-student interactions, student-student interactions, the use of audio-visuals, and practical demonstrations (Nae, 2019). Students were constantly encouraged to be active participants. The emphasis was on understanding and grasping the meaning, as opposed to simple mechanical memorization. This facilitated an environment that promotes long-term memory retention from the teacher's perspective. Teachers have shown that while the one-sided lesson seems to be the simplest form of teaching for students, this form of teaching also promotes the least effective way of long-term memorization by combining, relating, and interpreting the experience of the child.

The interactive teaching method enriches knowledge and develops skills, develops attention, the spirit of observation, memory, and imagination, forms motivation, and attitude towards various activities cultivates the spirit of inquiry, perseverance, and the spirit of cooperation (Kotasthane & Kotasthane, 2017). Our technological tools provide more and more opportunities for positive interactions and learning experiences if only we can find ways to nurture and develop them in dominant environments. Teacher-students and students-student discourse to understand the meaning of mathematical problems and to make it easy for problem-solving was the epicentre of the classrooms. Mathematical discourse, on the related subject matter, was used for understanding by questioning and brainstorming methods. However, the interactive teaching methods also use games, audio-visuals, story-telling, etc. to elaborate on the subject matter, which was not displayed as a part of teaching activities. This issue features a mix of articles discussing innovative ways to focus on student attention and activity through speed reading, smart boards and electronic textbooks, high and low attention modeling, and innovative learning environments, including simulations and views (Greener, 2018). In all of these examples, interaction remains at the heart of innovative learning and teaching practices. From the above information, I generated the following theme and interpreted it.

Transformation of Pedagogies

When I used to be a student at the high school level, the teaching method was fully teacher-centered. The teacher used to be the centre of knowledge and responsibility for learning as a banking pedagogy (Darder, 2018; Freire, 1970). Students generally received information passively. The role of the instructor was to provide the main information and the main assessor. Students were seen as "empty vessels" who passively received knowledge from their teachers. Teachers acted as the sole knowledge providers, and under the direct education model, teachers often used systematic lesson plans and scripts. We were only passive listeners to the teacher and if we asked classmates anything, phrases like "*don't talk*", "*keep quiet*", and "*don't make noise*" came to us. But, in my observation, the pedagogic activities were shifted to student-centered from teacher-centered although the authoritative power centre was the teachers.

I found that there were more discussions on the subject matter; students were free to ask questions and put their opinions. Nowadays, it broadly encompasses teaching methods that require students to actively develop their knowledge and give them responsibility for learning. The teacher still has an authoritative role, but students and teachers play an equally active role in the learning process. The main objective of the teacher is to educate and facilitate the learning and understanding of the subject matter by the students. Student-centered learning has become a pioneer in the development of the learning approach as it is an emerging and widely exercised approach.

In the student-centered approach, student activities are important indicators of the learning process and the quality of the learning product (Dong, Wu, Wang, & Peng, 2019; Zohrabi, Torabi, & Baybourdiani, 2012). In the teaching and learning of mathematics, this approach links to flexible learning, experiential learning, and self-directed learning (Acat & Dönmez, 2009). Thus, a student-centered classroom is a place where teachers consider the needs of students, as a group and as individuals, and encourage them to participate constantly in the learning process. The students actively participate in the learning process and the teachers help to guide the students, manage their activities, and guide their learning (Acharya et al., 2022; Singhal, 2017). Several activities in the learning process bring many benefits to the learning process in mathematics lessons. In the student-centered classroom, students can work alone, in pairs, or in groups (Zohrabi, Torabi, & Baybourdiani, 2012).

When students work on their own, they prepare ideas or take notes before class discussions, do listening homework, do short written assignments, or do problem-solving or numerical brainstorming. Students can work together in pairs or in groups to compare and discuss their own answers, or read and react to other classmates' work and suggest improvements (Trester, 2019). Students can work together in discussions or role-plays, sharing ideas, opinions, and experiences. In the same vein, Ameliana (2017) claims that these activities bring benefits to students, for example when students work together in Mathematics, they speak more, share their ideas, learn from each other, and feel more confident and less anxious in mathematics learning.

We often used to have conversations on the periphery of classroom activities of the mathematical discourse. After exiting the third classroom observation of Raj on 27th November 2019, he shared his views on classroom discourse related to the existing pedagogies of the classroom in mathematics.

Dialogue 1. Mathematics Pedagogy has Changed

BB: *How do you find teaching mathematics in community schools?*

Raj*: I teach all the classes by using teaching materials as much as possible. I also motivate students to make teaching materials by themselves, which further helps them to understand mathematical concepts clearly and deeply. To make teaching material by themselves, exposing their performance on the board among friends strengthens the confidence of students in mathematics learning. New emerging pedagogical activities are surely ICT-based classroom teaching. I frequently use this method. Here, we have a sophisticated ICT lab, and mathematics lab, for innovation in teaching-learning activities.*

BB: *Do you find any changes in pedagogical discourse in mathematics classrooms then and now?*

Raj: *Of course. There are various changes in mathematical pedagogies. In the past, we learned mathematics with fear, with pressure including punishment, and without interest but today's students are studying with games, collaboration, motivation, and interaction among one another.*

If mathematics is taught practically by using enough teaching materials, it is easy to understand the concept clearly. Most of the students take mathematics as a difficult subject and a subject that requires rote–learning. But all of the teachers claimed that, nowadays, students are learning in a very good environment. They have a good opportunity for the learning environment, ICT facility, group discussion, role-play, and the motivation of teachers.

Raj, including other mathematics teachers, claimed that the paradigm of classroom teaching-learning mathematics has been shifted from a traditional, rote-learning, teacher-centered, mono-cultural system to a collaborative, student-centered, multicultural, activity-based, and student-friendly system. The student-friendly and multicultural assimilation pedagogic activities are supportive factors to make classroom discourse relevant to the changing environment. From the above information, I generated the following theme and interpreted it.

On the 1st of December 2019, I observed the next mathematics class in class six. Nayantara Madam conducted this class. She was also an experienced, trained, and energetic teacher. As we were going to the classroom, she had a chart, an English medium textbook, a marker, and a board eraser. As we entered the classroom, all the students stood up and very politely greeted us. We also shared our greetings with them. Nayantara Madam introduced me to the students. She made me sit on the last bench in the classroom. There were 45 students in the classroom. Among these students, 20 were boys, and the rest of the students were girls. The classroom was furnished with the arrangement of 16 sets of desks and benches in three rows. Almost three students were sitting on each bench. There was a large display board on the wall of the backside of the classroom. I noticed the display board carefully. The display board was decorated with different English and Nepali works of literature, paintings, and drawings but I could not see any mathematical activity there.

Classroom Vignette 3: Teaching Algebraic Expressions

Teacher: *Today, we will learn to find the values of algebraic expressions.*

Students: [*Silent*.]

Teacher: *Let us suppose that, x = 3, y = 2, and z = 3 then find the value of 3xy* + 4yz. [She wrote on the whiteboard]. *This is one of the problems. If such kind of problem is given to us then we have to put the values of variables in the given expression. She spoke to students while writing.*

Solution,

Here, x = 3, y = 2 and z = 3

3xy + 4yz

= 3 × 3 ×2 + 4 × 2 ×3

= 18 + 24

= 42

A girl: *Ma'am, there is 3xy + 4yz. It is right? But in the second step, you put 3 × 3 × 2. 3 and 2 are the values of x and y respectively. Where does this '×' sign come from between 3 and 3, and 3 and 2?*

Teacher: *Oh, this?* [Underlined the × "*Inṭu*"[5] signs.]

$3 \underline{\times} 3 \underline{\times} 2 + 4 \underline{\times} 2 \underline{\times} 3$

A girl: *Yes, this 'Inṭu' sign.*

Teacher: *Who can say? Why is there an 'Inṭu' sign?*

Next girl: [Stood in her right place.] *If there is nothing between two variables, then there is 'Inṭu'.*

A boy: [Raised his hand and stood.] *Manita* (Next girl), *what is a variable?*

Teacher: *Manita, Gopal (A boy) is asking you. What is a variable?*

Manita: *Umm. Value.*

Teacher: *Manita, thank you. You sit down. English alphabet or any other expression that takes many values are called variables. Here, x, y, and z have 3, 2, and 3 values*

[5] Word used for multiplication sign.

respectively in this question but they may have different values for the next question. Therefore, x, y, and z are variables. If there is no other sign between the variable then there is a multiplication sign.

Next boy: *Then, ma'am, why didn't you write 3×x×y + 4×y×z instead of 3xy + 4yz?*

Teacher: *Both expressions 3×x×y + 4×y×z and 3xy + 4yz are the same but the second one looks tidier than the first expression. So, we prefer to write 3xy + 4yz than 3×x×y + 4×y×z. but we can write like,*

$$3xy + 4yz$$
$$= 3.\ 3\ .2 + 4.\ 2\ .3$$
$$= 18 + 24$$
$$= 42$$

Here, '×' and '.' are the same. They both have the same meaning. But, if we write 3.3 then it is confusing whether it is 3×3 or 3.3. That means '.' is decimal or multiply, it is ambiguous. So, we write 3×3. Are you clear now?

Students: [They nodded and indicated that they understood.]

Teacher: *Can you do this type of problem, now?*

Students: *Yes, miss. We can do it.*

Teacher: *Okay, you try to do this.*

If x = 2, y = 1 and z = 3 then find the value of: 2xy + yz + 23zx.

A girl: *Miss, is it similar to what you did?*

Teacher: *Yes, it is.*

Students hurried to solve the problem. Most of the students were busy solving the problem. A few students were seen copying from their friends and some of them were asking their friends.

S2: [Stood up and said], *my answer is 32. Is it correct, ma'am?*

Teacher: *Let me check it.* [She checked the exercise book.] *Okay, you are right.*

S1, S3, and S5: *I also have answer 22.*

Teacher: *Okay, I am coming to check that.* [She checked a few exercise books.] *Yes, yes, you are right.* [Taking S3's exercise book on hand], *your answer is correct, but do you know what, you missed? You missed putting an equal to "=" before each line. [Now, she corrected and], don't forget to put an equal to, okay.*

S3: *Okay, Miss.*

The teacher as well as the students were busy sharing their knowledge. In the classroom activities, I concluded that each student if they understood the concept shared this concept with their colleagues. The classroom environment was quite sound in teaching-learning activities. Students and teachers, students to students collaboratively, were ready and enthusiastic to transfer knowledge from each other's side. From the above information, I generated the following theme and interpreted it.

Freedom in the Mathematics Classroom

When I was a high school student, there was no freedom in the classroom because we had no permission to share our experiences with our classmates or to learn from the classmates. The class used to be led by a teacher with strict rules and regulations. Students were not allowed to talk to their classmates. Only the teacher spoke and the students were passive listeners in the classroom, but what I found from my observation was truly transformative pedagogic activities. Students and teachers both played constructive roles in making classroom discourse meaningful, objective, and understandable. The aspiration of teachers seemed to be student-friendly discourse in the classroom. In the classroom, there was complete freedom to ask questions to teachers, and classmates and to comment about others. The teacher played the role of a facilitator. Students spontaneously participated in the classroom activities. The teacher encouraged them to ask questions, helped them solve problems, and instructed them on how to solve problems if they made mistakes. Students were free to make mistakes and learn from the mistakes. The teacher asked the questions to passive students to create equality and equity for social justice in the classroom.

The freedom to ask questions, make queries, interact with classmates, and comment with friends is a democratic teaching practice. Democratic teaching practices can have a positive influence on students' learning outcomes in a mathematics class. This may be because a successful democratic teaching and learning process helps individuals think for themselves, judge independently, and distinguish between right and wrong information. Therefore, it is desirable or necessary to implement democratic practices in the mathematics classroom (Aasebø, 2017).

In the free learning environment of a mathematics classroom, students work together to solve problems that they consider an important part of the learning process. Drawing on their collective knowledge and experience, students develop the skills to locate relevant information when needed and use multiple representations to acquire new knowledge (Boaler, 2008). In the democratic mathematics classroom, all students have the resources and support they need to actively engage in the task at hand and develop the mathematical mental habits necessary to critically appraise information for advocacy (Ellis & Malloy, 2007). Students should have the opportunity to regularly communicate their ideas in writing and oral expressions. They should feel that they have a say in their learning and in directing the discourse in the classroom (Pugalee & Malloy, 1999). The teacher should listen to the stories and voices of each student, honour each child's life experience and promote alternative perspectives to learning mathematics.

After one of the classroom observations, Nayantara Miss (pseudonym), and I returned to the staff room. I observed that teachers were also discussing how to improve the teaching method in the classroom.

Dialogue 2. “Each One Teaches One” Policy

T1: *... and revised three times, but this ‘X’ student still could not understand.*

T2: *Yes, he is a slow learner. I also manage a few more minutes and treat him separately.*

T3: *Um… in my class too, I make students teach within small groups. He learns well in their group in their own way. I have followed, the rule that every student should teach other students. This method is useful, and …… and, in my subject. He is okay in class.*

T1: *Oh… I also use this way of teaching.*

In the process of very free and unauthentic conversations with teachers, they talked about the various pedagogic processes they have exercised in the classroom discourse of mathematics teaching. Among different pedagogies, if students are allowed to teach other weak students, it helps the students to deepen their understanding and clear the concept. This is one type of motivation for the students to prove that particular students can teach their friends. This symbolizes that some students have understood everything that the teacher taught them. Students further visit their textbooks, other available reference books, useful websites, and YouTube to enrich the concept. This process of “learning by doing” is the most important way of teaching mathematics. From the above information, I generated the following theme and interpreted it.

Learning Mathematics Through Doing by Students

Mathematics is very useful in everyday life. We use mathematics concepts, as well as the skills we learn by practicing mathematics problems every day. Mathematics provides us with a way to understand patterns, define relationships, and predict the future. It helps us to do a lot of important things in our daily life. Mathematics teachers (my participants) agree that there are many mathematics activities that students use in their daily lives, but they do not know how to relate these independent mathematics activities to classroom learning. Students estimate the distance between home and school and manage the time to get to school. They go to the market to buy different things in which the fundamental activities of mathematics such as addition, subtraction, multiplication, and division are applied. Every aspect of life is heavily dependent on the use of numbers and arithmetic. Mathematics improves a person's cognitive and decision-making abilities. Mathematics is used in our dates, times, and calendars. Mathematics is everywhere and applied in all aspects of life, but students think they would only find it in their textbooks.

> Mathematics is the key to opportunity. No longer just a language of science, mathematics now contributes in direct and fundamental ways to business, finance, health and defence. For students, it opens the doors to careers. For citizens, it enables informed decisions. For nations, it provides knowledge to compete in a technological economy. (National Research Council, 1989, p. 1)

Teachers should be responsible for showing students mathematics in their daily activities. Mathematics also plays an important role in cooking skills. Each ingredient has to be measured, and sometimes it is necessary to multiply or divide to get the exact amount we need. Mathematics helps people manage their money by balancing their cheque books or shopping at the most expensive prices. Calculating bills, financial obligations, taxes, insurance, and loans all are mathematical activities. In the practical approach to mathematics in school, students manipulate concrete objects and carry out activities to arrive at a conceptual understanding of phenomena, situations, or concepts. The environment is a laboratory where natural events/phenomena can be the subject of mathematical or scientific investigations. Mathematics makes our lives orderly and prevents chaos. Some qualities cultivated by mathematics are the power of reasoning, creativity, abstract or spatial thinking, critical thinking, the ability to solve problems, and even effective communication skills.

Regarding the teachers' perception, their knowledge of teaching, experiences, and classroom discourse has variability. The personal performance of teachers expresses their cultural climate in the entire classroom which used to be a matter of greater importance.

In an interview with Sanjog, it was claimed that mathematics teaching was a multi-dynamic and prestigious job among the students, teachers, and the community.

Dialogue 3. Mathematics Teaching is a Prestigious Job

BB: *Sanjog sir, how do you take the teaching profession?*

Sanjog: *Well, it is one of the prestigious professions. Many people look at the teacher as a well-known person, an educated person, and a pathfinder of society. Therefore, I feel proud of myself for getting involved in this teaching profession.*

BB: *In your opinion, what matters the mathematics education?*

Sanjog: *Mathematics education is of greater importance. It plays a vital role in our everyday life in scientific research. Modern life demands the requirement to have good mathematical knowledge. Mathematics is important for life and supports overall* *personal development. Mathematics is also connected and applied to different subjects and fields. We can find mathematical applications in nature, technology, machinery, architecture, the building industry, the banking sector, research, hypothesis testing, quantitative analysis, budgeting, planning, etc.*

BB: *What do you do to improve the status of weak students?*

Sanjog: *In my experience of teaching, each classroom is a heterogeneous mixture of different cognitive levels of students. Especially to grow the level of weak students, I regularly check their homework, give them more time, and try to involve them in the classroom discourse. One way of improving them is that their seat is arranged together with the students who know well and they teach the weak ones.*

BB: *What is the role of teaching materials in the teaching of mathematics?*

Sanjog: *I think teaching materials are not everything but they help in some topics in geometry and mensuration. Teaching materials cannot easily be used in topics like algebra and trigonometry.*

BB: *How often do you use a lesson plan in mathematics teaching?*

Sanjog: *It is not necessary to make a lesson plan for everyday teaching. The lesson plan helps novice teachers. But, every teacher should be aware of what chapter is s/he going to teach today. What teaching methods are used?*

From the above information, I generated the following theme and interpreted it.

Mathematics is Multi-dynamic and Prestigious

In my research procedures, I have found that mathematics teachers take pride in what they do today. They also claimed that they were superior to teachers of other subjects and the beliefs of the students were similar in the field of classroom teaching. In school, mathematics was seen as a more difficult and complex subject, and of great importance. Besides mathematics and science subjects, other general subjects could be taught by anyone, but mathematics and science require a specific teacher. Mathematics teachers had an opportunity for extra classes, coaching, and even personal and group tuition strengthening them economically (Duc & Baulch, 2012). Mathematics teaching is one of the prestigious professions. Many people regard the teacher as a well-known, educated, and pioneering teacher in society. Therefore, mathematics teachers felt proud of themselves involved in this teaching profession. The teaching of mathematics was more important as Modern life demands the requirement of having good mathematical knowledge. Mathematics is important in life and supports balanced personal development. Mathematics was also related and applied to different subjects and fields. People could find mathematical applications in nature, technology, machinery, architecture, construction, banking, research, hypothesis testing, quantitative analysis, budgeting, planning, etc.

In the vision of Wegner (2008), mathematics is one of the oldest and most important sciences. Mathematical knowledge is essential for any work of analysis and understanding. At first, it was firmly linked with other sciences such as astronomy and physics. Later, it partially transformed into an independent science called pure mathematics. Today mathematics is a part of the fundamental sciences which, in addition to its classic fields of application, is present everywhere; in psychology, sport, the arts, medicine, food technologies, games, markets, and many other sectors. Within this tradition, mathematics occupies a stable place in education, from elementary school to university education which deals with a wide range of mathematical applications and services (Schoen & LaVenia, 2019). Therefore, mathematics has a great scope in the field of teaching, it is connected with other subjects and is applied.

Classroom Discourse from School B

I went to school B on 1st January 2020 for the first time. The school was situated just opposite Nepal Rastra Bank and the school was encircled by a small compound nearby the beautiful temple. The office of Kathmandu metropolitan city, Ward number 4, was also attached to this school. The school building was under construction with the assistance of funding from the Embassy of India. A small building was used to teach students in two shifts due to the scarcity of teaching places. There, I met the head-teacher in the school office and talked about the newly constructed school building; students' class management; and a few other topics.

During the conversation, I put my aim to come to this school. The head-teacher accepted what my aim was for his school. He requested me to come the next Sunday so that he could meet me with the mathematics teachers at the school premises. Again, I visited the school the next Sunday. The head-teacher introduced me to two mathematics teachers and other teachers as well. After the introduction with a cup of black tea, I and the mathematics teachers had a conversation for about 15 minutes about our classroom observations. The mathematics teachers permitted me to observe any mathematics classes as my requirement during school hours with the pre-information.

In the same school, I observed the classroom discourse in class ten. This class was going to be taken by Mr. Tenzing. He was a tall, healthy, and energetic teacher who was taught in that school for 7 years. He had mathematics teaching experience in a private school for more than a decade. In my understanding, he had made a different identity of ‘strictness’ in the school. All the students knew him as a strict teacher because he hardly allowed his students to talk with their classmates while teaching.

Before the class, he had taken two board markers and a whiteboard cleaner. As we entered the classroom, all the students stood up and greeted us, we also exchanged greetings. There were 57 students in the classroom and it seemed to be congested despite the classroom being large. There was a large whiteboard and two display boards on the front side of the classroom. The display board was full of learning materials placed in a well-organized way. I felt happy seeing that most of the materials were mathematics. The display board was covered with mathematical formulae, equations, geometrical figures, and solved problems. The classroom was a pin-drop silence and every student was well-prepared to learn with the necessary books, pens, pencils, erasers, geometric boxes, etc. Students were seated in highly-alarming positions. Without any delay, the teacher wrote a geometric theorem on the whiteboard. He neither used any book nor said where it was in the book.

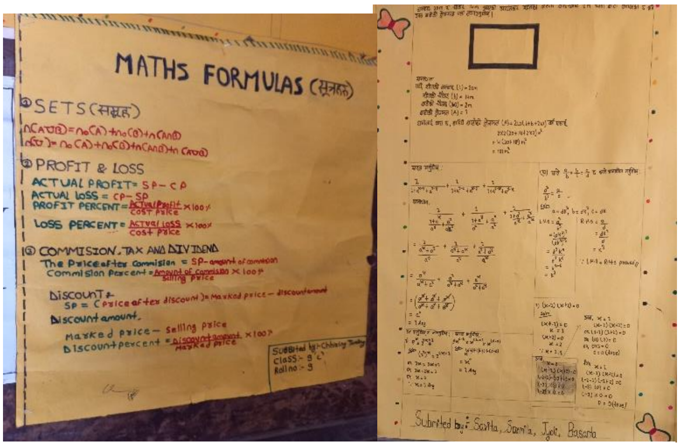


Figure 5. Formulae List on the Classroom Display Board [Field Photograph]

Classroom vignette 4: Teaching of Geometry

Question:

In the given figure, PQRS is a parallelogram in which RQ is produced up to N, and SN and PN are joined where SN meets PQ at M. Prove that the triangles ΔPMN = ΔRMQ are equal in area.

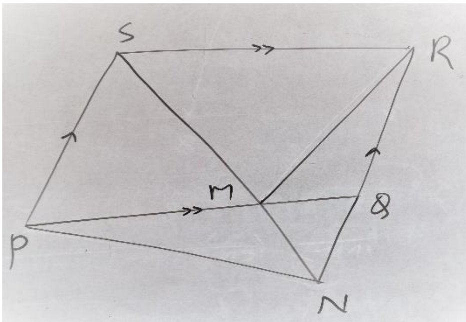


Figure 6. Teacher's Drawing of Geometric Figure [Field Photograph]

Solution:

1. Given: PQRS is a parallelogram in which RQ is produced to N such that RN||SP.
2. To prove: ΔPMN = ΔRMQ in area.

Proof

S.N	Statements	S.N	Reasons
1.	ΔSMR = $\frac{1}{2}$□PQRS	1.	Both are on the same base SR and between the same parallels SR and PQ
2.	But ΔSMR + (ΔPMS + ΔRMQ) = □PQRS	2.	Whole part axiom.
3.	∴ ΔPMS + ΔRMQ = $\frac{1}{2}$□PQRS	3.	From (1) and (2)
4	But ΔPSN = $\frac{1}{2}$□PQRS	4.	Both are on the same base PS and between the same parallels PS and
5.	∴ ΔPSN = ΔPMS + ΔRMQ	5.	From (3) and (4).
6.	∴ ΔPSN - ΔPSM = ΔPMS +ΔRMQ - ΔPSM	6.	Subtracting the same ΔPSM from both sides of statement 5.
7.	∴ ΔPMN = ΔRMQ	7.	Whole part axiom.

Explanation: After writing the question on the whiteboard, the teacher made a fine figure on the right side of the board nearby the question. He explained the question very clearly three or four times to minimize confusion about the question. He explained about each line, triangle, and parallelogram formed in the combined figure. Then he shaded the two triangles which were to be shown equally in the area. Thereafter, the teacher wrote what was given in the figure and what was asked to prove in the figure. The teacher made a table and wrote two main headings 'statements' and 'reasons'. The teacher divided the combined figure into many simple figures so that students could easily understand the different areas of the figure and also explained the relationship between triangles and parallelograms standing on the same base and between the same parallel lines. The teacher's appearance, skills to teach, commanding voice, and confidence in teaching were spell- bounding to every learner.

In this classroom observation, I found that the teacher was very confident and experienced in teaching mathematics, but he lacked conversation with students. The classroom discourse was unidirectional, and only the teacher explained everything to make it clear to the students. He never asked a single question to the students about whether they understood what he was teaching or not in the entire classroom discourse. But, none of the students asked the question to him, and the students were fully concentrated on learning. The teacher did not use any teaching materials in the classroom teaching process, but the teacher was fully prepared about what he was going to teach because, without any book, he stated the question on the whiteboard and made an attractive and well-labelled figure.

In the words of Otten, Engledowl, and Spain (2015), univocal discourse, characterized by its function of conveying information from one person to another, is common in mathematics classrooms but dialogic teaching aims at students coming to participate in the dialogic discourse. The dialogic discourse functions to generate new meaning within a community. Univocal discourse is characterized by communication in which the listener receives the ‘exact’ message that the speaker intends for the listener to receive. Once the speaker’s intended meaning has been conveyed, the episode of univocal communication is considered to be successfully finished (Knuth & Peressini, 2001). Further, Lotman (1988) adds dialogic discourse, in contrast, is characterized by give-and-take communication in which the listener initially receives the ‘exact’ message sent by the speaker. At this point, univocal discourse ends, but the dialogic discourse has just begun. In the case of Tenzing's classroom discourse, there was only univocal discourse from the teacher’s side. This classroom discourse and environment forced me to remember my school’s mathematics classroom when I was a student. Univocal discourse is used when teachers give important information to students and dialogic discourse confirms and clarifies the confusion of the students about the provided information. Univocal discourse orchestrates one-way rules, regulations, knowledge, and skills whereas dialogic discourse creates a student-friendly environment in the classroom. Dialogic discourse in the classroom generates meaning by using dialogue as a ‘thinking device’. Both students and teachers are responsible for contributing to discussions to make the classroom discourse meaningful.

The Sternness of Mathematics Teachers

After the observation of the classroom teaching of Mr. Tenzing, I wanted to understand the group perceptions of the students about the classroom pedagogy style. For this, I conducted a focus group discussion (FGD). To conduct FGD, I purposefully selected five students and involved them in the FGD at the library of school B. I raised the issues of classroom discourse of the teachers and its impact on classroom pedagogy. The information was recorded and note-keeping was done for the entire process. A small clip is shown below.

BB: *As I have listened, Tenzing sir is a strict teacher. You have studied a lot with him. How do you feel?*

Manita: *Yes, you are right to some extent but not totally. He teaches us very nicely in the classroom. He can make us understand in class by adding relevant examples that are used in our daily lives. He controls the class strictly but teaches carefully. But, if we are confused about any topics or problems, we are frightened to ask him.*

Sonam: *I think that he is a strict teacher. In my opinion, the mathematics teacher should be strict so that there is no noise in the classroom and we can understand well. I am afraid to ask questions with him easily as in other subjects.*

Ashmita: *I dislike his behaviour, although he teaches well. He has a bad habit that we are not allowed to share with our friends. If he sees us asking friends, he scolds us and motivates us to only ask him. And if we ask him, he often says, "What were you doing while teaching?"*

Chhemang: *Sir is a little strict, and because of a little fear, our mathematics study is good. If he were not strict, we would openly ask about our problems with him, and we would be more skilled in the mathematics subject matter.*

Ajay: *Sir is a little bit strict and checks our homework regularly. If we make a minor mistake, he makes us redo it. Thus, we have a great opportunity to learn more in a noiseless environment. There would be unnecessary noise in the lower grades and a few students used to disturb the class by making noise. I used to understand mathematics less clearly because of the noise and the tolerability of the mathematics teacher in the lower grades.* But, in the lower grades, the mathematics teacher allowed us to share our experiences and understanding so that I had a chance to get support from my colleagues.

Regarding the FGD of the students, they liked the strict teacher rather than the lenient one in subjects like mathematics, but they were afraid to ask questions to the teacher. Each student was very aware of their study, and they thought that strict teachers did not allow students to share their experiences and understanding of the subject matter with their colleagues. Students shared their views that their studies would be miserable in mathematics if the teacher was lenient instead of strict because the fear factor of the teacher also forced them to learn mathematics. Therefore, students preferred an honest, hardworking, capable teacher to control the classroom and a motivating teacher in mathematics teaching rather than strict ones. Students somehow adjusted to teacher-centered classrooms, lecture-style teaching, and univocal classroom discourse, but they would be happier in student-centered classrooms, practical-style teaching, and dialogic classroom discourse. The students said that the teaching materials were somewhat helpful in learning mathematics, but if the teachers are experienced and can teach in a controlled classroom, they can do more than the teaching materials.

Strict teachers are not preferred by students learning mathematics because they can create an environment of fear and intimidation, which can make it difficult for students to ask questions or take risks in their learning (Aguilar, 2021). Additionally, strict teachers may not be as patient or understanding when it comes to helping students understand difficult concepts, which can lead to frustration and a lack of motivation. Strict teachers may also be less likely to provide positive reinforcement or praise for students' efforts, which can lead to a lack of confidence and a feeling of discouragement. Strict teachers may also be less likely to provide individualized instruction or support, which can make it difficult for students to understand the material and progress in their learning (Kunwar, 2021). A student does not typically learn from the fear factor of a teacher. Fear can create an environment of intimidation and anxiety, which can make it difficult for students to focus on learning and can lead to a lack of motivation (Kunwar, 2021). Additionally, fear can lead to a lack of trust between the teacher and student, which can make it difficult for the student to ask questions or take risks in their learning.

In this context, Wachira, Pourdavood, and Skitzki (2013) argue that mathematics instruction should provide students with opportunities to engage in mathematical inquiry and meaning-making through discourse. While there have been successes to this end, traditional models of instruction still dominate mathematics education, especially at the high school level. This can be attributed, in part to the teachers' role and their ability to successfully organize and facilitate collaborative classroom practices as called for by the reform movement. If any teacher is strict for a good reason for students' performance, controls unnecessary talks, and motivates learning, then it is highly accepted in low-performing institutions (Poplin, et al., 2011). Teachers' pedagogy style is mainly dominated by the curriculum and the evaluation system in the nation. In mathematics classrooms, lessons are teacher-dominated with a chalk-and-talk approach, and learning is process-oriented in developing countries whereas lessons are interactive-communicative or/and interactive-conversational in developed countries (Kaiser & Vollstedt, 2007). As Nepal is a developing country, our mathematics classrooms are often teacher-dominated, teacher-centric, and followed by lecture-style pedagogy, which was seen in most of the observations.

I observed 4 classes of Mr. Tenzing but all the classes were handled in the same way. I found nothing new in different classes. His genre of classroom handling was unique and followed the same pattern. Mr. Tenzing liked to speak less but in a more meaningful way.

We have had a conversation about the issue of classroom discourse in mathematics, in a very peaceful environment.

BB: *In my observation of your classroom teaching, I did not find any use of teaching materials. Don't you think teaching materials can help in classroom discourse?*

Mr. Tenzing: *Yes, probably the teaching materials can help in the classroom discourse to give the very basic concepts of the related topics, mostly at pre-primary and primary levels. But, at the secondary level, only a few topics can make use of the teaching materials, not all.*

BB*: In your opinion, how do students understand easily and well in mathematics?*

Mr. Tenzing*: It depends upon students' learning capacity, pre-knowledge, and aspiration of learning. A teacher's capacity to make them understand is another important thing. The classroom should be controlled and silent so that students can listen to teachers carefully and teachers can systematically explain everything without any disturbance. Frequent revision of the taught exercises can help to remember the methods, applied formulae, and problem-solving skills for a long time.*

BB: *In the current situation, how do you find mathematics teaching?*

Mr. Tenzing: *Students have taken mathematics as a difficult subject. Students can learn other subjects by themselves but they cannot do mathematics without the help of teachers. Although mathematics is one of the practical subjects, there is a provision of 25% practical marks in other compulsory subjects except for mathematics. The school has also given more priority to mathematics subjects. Thinking all about these* *factors, mathematics teaching is not easy work. Again, what happens in mathematics is that the students go on forgetting after a while what is taught. Therefore, teaching and frequent revisions are necessary to make good learners in mathematics. In my experience, I have found that a little fear is also necessary. If I tell them to do their homework in soft words, only a few students do but the same thing is said in strict words, almost everyone does. It is said that people do everything either out of interest, pressure, or fear. In our society, only a few students learn with interest and more with fear*.

In the above conversation with Mr. Tenzing, he accepted that the use of teaching materials can help in the classroom discourse of mathematics in primary grades, although, he never used the teaching materials in my classroom observation. He claimed that teaching materials were useful at pre-primary and primary levels to understand the basic concepts of mathematics but only a few chapters could employ the teaching materials in higher-level teaching. He talked about '*classroom control'* which meant that his teaching pattern was strictly teacher-centric and the complete lecture method was followed in the classroom discourse. Mr. Tenzing claimed that only a few students studied with their interest and more of the students studied with fear which was meant by his quote "*…people do everything either by interest, pressure or by fear* [Sabai janālē ki rahara, ki kara, vā ki ta ḍaralē kāma gardachan. सबै जनाले कि रहर, कि कर, वा कि त डरले काम गर्दछन् ।[6]]". The teacher intended that if students studied with their interest then it was fine, otherwise, they should be taught with the fear of some punishments, which was against the student-friendly classroom discourse.

[6] Nepali script for *" people do everything either by interest, pressure or by fear"*

I wanted to know what the existing theories say about the punishment of the students and in my research, I found three theories about the students' punishment regarding learning –reformation, retribution, and deterrence. In the perception of Tarimo (2006), the reformation theory views punishment as the only possible way to reform or recreate an individual. It assumes that punishment has corrective effects on learning because punished students will not repeat misbehaving. The retribution theory says that punishment may cause negative relationships between a student and the teacher as the student can try to find different ways to retaliate for an action that has been punished (Cicognani, 2004). According to Gershoff (2002), the deterrence theory states that if other people see or hear severe punishment given to offenders, they will refrain from doing that offense in the future. This is applicable in social crime and military actions but against the punishment for learners in the classroom.

Although the teacher talked about student punishment for the betterment of learning, I saw no evidence in my classroom observations of students participating in any form of punishment. Generally, punishment in schools seems to be an ineffective, dangerous, and unacceptable method of controlling and maintaining behaviour and discipline as it brings negative rather than positive consequences in the whole process of teaching and learning activities (Lawrent, 2012). Beginning teachers tend to restore punishment in case the pupils persist in making mistakes. Beginning teachers keep very attentive track of mistakes, and the breach of previously established rules by disturbing pupils. For the pupils to prove efforts to correct themselves, this method must no longer be applied (Claudiu, 2014; Kozlowski, 2021). Furthermore, Lawrent (2012) claims that physical punishment seems to increase child aggression, increase antisocial behaviour, lower intellectual achievements, enhance the poor quality of teacher-student relationships, and cause mental health problems. It is important to note that good school discipline depends not only on non-violent responses to poor student behaviour but on skilled and properly trained teachers to handle the expected classroom discourse.

I observed the next classroom at the same school on Wednesday, 15th January 2020. This classroom was going to be handled by Mr. Hari Singh in class six. While we were going to the classroom, the teacher had large rural, mathematics textbooks in Nepali and English, a few sheets of paper, board markers, and a whiteboard eraser. The classroom consisted of 37 students, out of which, 25 were girls and the remaining were boys. There was enough space for students as the classroom was large. Two or three students were seated on each bench and a few dusty benches were empty. I asked for a piece of paper from a girl, swiped the desk and bench, and sat on the empty bench. There was a small whiteboard in the classroom and a big display board nearby the whiteboard. The display board was almost empty, only two cartoons drawn by students and a poem written in Nepali were placed on it. He was going to teach "Intersecting and Parallel Lines". His tone of teaching made me notice that his mother language was neither Nepali nor English. He was from the Terai region and his voice was accented with the local style. He seemed to be feeling uneasy in speaking Nepali and English but his speech was very fast.

Teaching Geometry Through Inductive Way for Better Discourse

Geometric objects or artefacts can be found everywhere in our locality. Whether students and teachers are aware of it or not, geometry is all around them. Geometry is encoded in each of our constructions and designs such as doors, windows, picture frames, architecture, engineering, interior design and decoration, urban planning, and even fashion design. Students can learn geometrical concepts by playing with geometrical tools such as rulers, protractors, dividers, compasses, and squares. Geometry is just the field of mathematics where the geometric concepts of lines, parallel lines, angles, triangles, quadrilaterals, circles, and semicircles can be seen in each of our constructions as well as a natural phenomenon. When geometric concepts are used correctly and manipulatively in the classroom, discourse can connect many areas of student life and possible future careers, and the spatial thinking that underlies this subject is critical to student academic success. The tools and techniques explored in orchestrating geometric concepts for students not only help them achieve academic success but also equip them with spatial thinking and problem-solving skills to use throughout their careers. Additionally, teachers could develop strategies to blend the study of geometry with other disciplines such as language, art, project-based learning, and other creative endeavours.

Classroom Vignette 5: Teaching of Geometry in Class 6

Teacher: *Today, we are going to learn about "Intersecting and Parallel Lines".*

[Teacher wrote the date, subject, and topic on the whiteboard.]

Students: [Affirmative nodding.]

Teacher: *What do you know about parallel lines?*

One of the Girls: *I know, I know.* [Raising hand.]

Other students: *Ha ha ha….hoo …* [Laughs]

One of the boys: *Oye, …, She knows it even without teaching it. Wow, it's a danger?*

Few students: *Ha ha ha ha*….. [Choral laughing.]

Teacher: *Perisha, what do you know? Say.* [*Timi bhannu hōs*][7] [Teacher's tone in his mother language accent.]

[7] Teacher's tone in his mother tongue acent.

Perisha: *Lines that do not intersect with each other as we make longer and longer are called parallel lines.*

Teacher: *Oh, very good. Give her clapping.*

Students: …. [Clapping and laughing.]

Teacher: *Did you listen to Perisha?*

Students: [Affirmative nodding.]

Teacher: [Taking a textbook in his hand and showing it to students.] *Here, you can see four lines.* [Showing the edges of the book.] *This line is parallel to this line because they never meet each other.* [Showing opposite lines.] *Again, you see this whiteboard and consider that the edges are the lines. These opposite lines never meet together. Similarly, you can see the door, windows, and ceiling, each of these plane surfaces has four lines and they never meet together. Can you give me some examples similar to what I gave you?*

Students: *Yes.* [Choral Voice.]

One of the boys: [Stood up from his place and said.] *Sir, I can give it.*

Teacher: *Okay. You say, Manoj.*

Manoj: *This display board and… and my exercise book, Gundriko taan, money notes.*

Teacher: *Thank you. Thank you. You sit down.*

A girl: *Sir, this desk. A carpet in my home, photo frame, television,…* [Sitting.]

Teacher: *Who told this?*

Next girl: *Sir, Anjali.*

Teacher: *Yes, Anjali is also right.*

Teacher: [Showing a large ruler.] *What about this?*

Students: *Yes sir, this ruler has also parallel lines.*

Teacher: *Yeah, Now you got the concept.*

Students: [Silence.]

Teacher: [Drew different patterns of parallel lines and intersecting lines.] *The two straight lines which do not meet together and have equal widths in them are called parallel lines.*

Students: [Silence.]

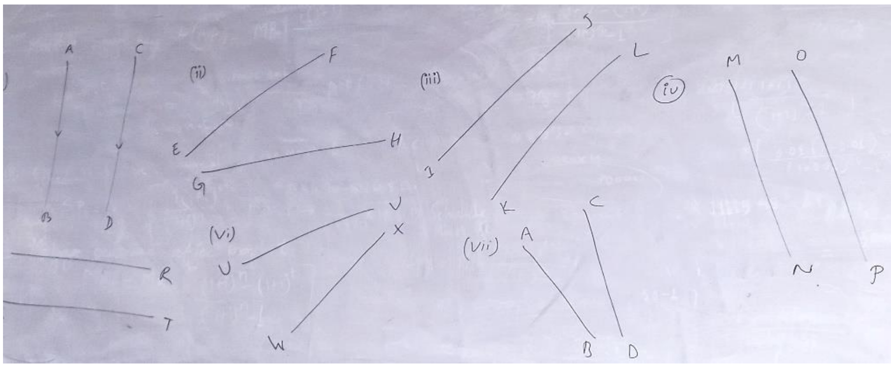


Figure 7. Parallel and Non-parallel Lines Drawn by Mathematics Teacher [Field Photograph]

Teacher: *Can you tell me now, which of these lines are parallel?*

Students: *This (i) is parallel, and this (iii) is not parallel…* [Choral Voice.]

In my classroom observation, I found that the teacher was very active and seemed to have prepared for the classroom discourse, although I did not notice using any teaching materials in the written plan. The teacher used his teaching from the questioning to the students which helped to judge the pre-knowledge of students. The teacher was experienced in engaging the students in the classroom with the immense use of examples. The teacher used the words/phrases '*very good'*, '*thank you'*, and '*give her clapping'* to motivate students. The teaching method used in the classroom was mixed and dominated by the inductive method because the teacher used examples within themselves and succeeded in making the visionary about what he was teaching. Finally, students were capable of distinguishing the parallel and intersecting lines from the application of the inductive method. Students seemed to be happy and somehow participated with the teacher. Students were collaborative in learning and discussion, which was not enough in the classroom.

In this perspective, Singh and Yadav (2017) state their view that teaching mathematics involves different methods at different levels of education as they differ in age, maturity, mental abilities, mental development, mathematical understanding, etc. Therefore, one method cannot be applied to teach mathematics to all the classes. Besides this, with the use of one method, all the students of a class cannot be equipped with an equal amount of knowledge because individual difference lies among them. The teaching of mathematics comprises two clear-cut parts. The establishment of a formula or rule and application of that rule to solve the problems. The former part is the work of induction. Thus, mathematics in the making is inductive and its finished form is deductive. In other words, mathematics is understood inductively and applied deductively (Singh & Yadav, 2017). In classroom observations, students noticed parallel lines on rulers, display boards, and the edges of books. It is an inductive method of teaching and learning. The concept of parallel lines can be applied to the construction of parallelograms, which are applied subtractively. Therefore, teaching and learning mathematics uses inductive and deductive methods simultaneously. Abstract knowledge, such as mathematical knowledge, is often difficult to acquire and even more difficult to apply to novel situations. In these situations, related concrete examples are helpful to the learners to conceptualize abstract things (Kaminski, Sloutsky, & Heckler, 2008). In the sense of understanding, examples play a central and crucial role in mathematics discourse at the high school level (Bills et al., 2006).

In the views of Prince and Felder (2006) instructors who set out to implement an inductive method and extensive examples in mathematics teaching should, therefore, first familiarize students with best practices such as providing adequate scaffolding – extensive support and guidance when students are first introduced to the method, followed by the gradual withdrawal of the support as the students gain more experience and confidence in its use. In a similar study, Hartley, Butler, and Wren (1942) found that primitive people first derived their knowledge of geometry from natural objects and later also from art. The need that arose to understand and continue the legacy of art, architecture, surveying, etc. provided the impetus for the development of the science of geometry, symmetry, congruence, and similarity arose and provided a solid foundation for the science of geometry.

In addition, Hartley, Butler, and Wren (1942) suggested that high school students should learn geometric concepts. Therefore, junior high school needs to systematize and extend geometric information to some of the broader and more general aspects of geometry in everyday life. Practical geometrical discourse helps the student become familiar with basic geometric concepts and understand basic techniques such as the use of a ruler, protractor, compass, and construction and measurement techniques to introduce the student to the characteristics of a good geometric concept. Completing the gap between the large-scale manipulation of geometric experiences and the more formal logical processes of demonstrative geometry creates interest in learning (Hemphill, 2010). Practically teaching geometry with the use of cultural artefacts or mathematical modeling has been called "intuitive", but it is more of an ingenious geometry, characterized by intuition, experimentation, and an informal approach to the more formal logical processes of demonstrative geometry (Bussi, 2020). Mathematics teaching by using the inductive method including embodied examples is beneficial to the learners by connecting lively cultural artefacts.

Cultural Integration in Mathematics Discourse

If someone is looking for answers to the question of why students find learning mathematics difficult, one of the answers given by many is to teach mathematics without being in tune with their daily activities, practicality, and culture. When I observed Miss Usha’s classroom discourse on mathematics with cultural eyes, I found that there were fewer cultural and everyday activities connected to the discourse. Students and teachers in the classroom were the social and cultural units and they combined to create multiculturism which can be defined as the beliefs, values, attitudes, customs, social relations, art, and literature that define an ethnic group of people (Banks, 2008). Mathematical concepts based on cultural perspectives allow students not only to reflect and appreciate their own culture but also the culture and traditions of others. The involvement of real-life practice is an essential part of integrating cultural components into mathematics activities. In the same line, I asked my participant mathematics teachers "*What do you do to integrate cultural celebrations into mathematics teaching? Is there any cultural connection between mathematics textbooks and curricula?"* They replied,

Figure 8. A Student Measuring the Length of Nepali Fifty-rupee Note

Usha: *One way to integrate cultural activities into the mathematics discourse is to incorporate traditional Nepali games and activities into the mathematics discourse. For example, there are games like dandi biyo, gatta khelne, and kabaddi that are useful for teaching measurements. Students can learn about* *probability and statistics by playing traditional Nepali card games, or they can learn about geometry by observing the doors, and windows of traditional Nepali buildings. Additionally, teachers can use traditional Nepali stories and songs to introduce mathematical concepts for lower grades like jaba bhayo ek bhuima khutta tek, etc. Sometimes, I organize field trips to local cultural sites to explore the mathematics behind traditional Nepali architecture and art. Especially, I make visits to students in some temple areas and museums. I share the experiences of mathematical connections to our existing artefacts. These concepts are neither incorporated in the mathematics curriculum nor textbooks yet.*

Raj: *I think the best way to integrate our home cultures into the mathematics discourse is to provide real-life activities for the students. For example, when students cut vegetables and fruits, they are taught to measure the length, breadth, weight, and volume. When they make roti, they are taught to measure diameter, radius, arc, and area. Students have seen different ornaments and statues; these concepts can be integrated into different concepts of mathematics. However, only mathematics teachers cannot do these things because they do not know all the activities of different communities. Community members should be aware of this. I think a different curriculum and textbooks should be developed because the existing curriculum and textbooks lack these concepts.*

Nayantara: *I think our existing mathematics curriculum and textbooks are not relevant to the cultural connections of our existing cultures. I think it is a difficult job to include the different cultures of diverse communities in a curriculum and textbooks. Mathematics teachers are not trained for cultural* *connections to mathematics discourse, but in my case, I use and provide the existing relevant examples during classroom discourse. I motivate students to make a set of members of vessels measuring volume and area from traditional things while teaching set theory. I motivate students to find and make a list of triangular, square, rectangular, circular, pentagonal, and hexagonal things that they have seen in their real lives.*

From the information I collected from classroom observation, FGDs, and in-depth interviews, it was clear that mathematics curricula and textbooks have not incorporated the existing cultures of any communities. Factually, they are culture-free. In my classroom observation, I could not see any cultural artefacts, songs, or stories applied to teach any topic by any teacher, but I noticed examples used to clarify the mathematical concepts from cultural and real-life activities. Almost all the teachers said "This can be done, and that can be done", but actually, I could not find proof of doing as said. Students said that they are sometimes given opportunities to visit temple areas and museums, and teachers asked some questions relating to mathematics and even explained the concepts. When teachers started the mathematics lessons, they usually started with examples that were seen and experienced by the students, so that the mathematical concepts were easily established among them.

In our community, a variety of mathematical tasks are performed in daily life such as making windows, doors, photo frames, clothing, and cooking involving the concept of parallel lines. If these tasks are practically presented in classroom discourse, learning is sustained. In the classroom discourse, students gave the example of *Gundriko taan*, ruler, exercise book, carpet, television, money notes, etc. because they have seen and used these objects in their practical life.

Teaching behaviour is the complex combination of knowledge, strategies, attitudes, beliefs, and values used by teachers to impart knowledge (D'Entremont, 2015). It is the teacher's responsibility to understand cultural diversity within their classroom. It is this knowledge that will create favourable communication between the teacher, the student, and the learner. Schools must create environments conducive to cultural exchange. Daily situations can be linked to students' social activities with their friends and family. Making the connection between home and school can be best achieved when classroom practices are culturally appropriate (Acharya et al., 2021). Identifying cultural practices that can be incorporated into mathematics education is not as easy as it sounds. It takes extra effort, patience, and understanding on the part of teachers just to become culturally sensitive in classroom discourse. Traditional cultural games, measurement methods, customs, jewellery, pottery, sculptures of stone and wood, sewing-weaving, etc. are concepts of lively practices of mathematics. These practices show that mathematics does have cultural relevance (Khanal et al., 2021; Samaupan, 2019). Thus, participants' views on contextualizing mathematics education to enhance and promote cultural capital through teaching and learning mathematics indicate the need for teacher motivation and integration of concepts of mathematics into cultural rituals and real-life practices. The notion of local cultural knowledge for teaching involves teaching basic mathematics with examples using cultural artefacts and transforming the teacher's curriculum and practice (Acharya et al., 2021). Teachers were positive about integration; however, they lacked the knowledge and skills to properly implement this didactic innovation in their classrooms.

These knowledge gaps limited the extent to which teachers explore interdisciplinary links. Teacher knowledge is a prerequisite for making connections between subjects in the area of culturally relevant pedagogy that empowers students intellectually, socially, emotionally, and politically by using cultural referents to convey knowledge, skills, and attitudes (D'Entremont, 2015). It also enriches the mathematics curriculum with real-life examples from many cultures, thereby increasing the ability of students to make connections within mathematics and between disciplines (Stemn, 2010). Therefore, the classroom discourse of mathematics without connecting with the existing culture, cultural artefacts, and everyday activities becomes meaningless.

Classroom Discourse from School C

I went to School C, on the 6th of September, 2019. It was Monday and the time was around 11 AM. The school was established in 2013 BS, which was mentioned on the main gate of the semi-circular School's name board. When I entered the school, the gatekeeper asked me about the aim of my visit there. My reply was to meet the head-teacher of the school. From the gatekeeper, I knew that the head-teacher was on leave. The gatekeeper suggested meeting the assistant head-teacher at his office in room number 10. I went to the assistant head-teacher's cabin, he was reading the newspaper, when I saw him first. We had a conversation about my purpose for an hour. He reacted very positively and was advised to observe his class, in class 10. He was a mathematics teacher and has been teaching for more than three decades in five different schools within the nation. He was there for the last 12 years and worked as an assistant head-teacher for 6 years. He offered me a cup of black coffee, and while drinking, we met other three mathematics teachers in his room. We discussed about my purpose to be there briefly. We exchanged our introduction and contact numbers there, in the small and congested cabin of the assistant head-teacher. The school was nearby two crossroads. There was a frequent disturbance of vehicles' horns, people’s noise, and sounds from the motorcycle garage. That made me feel that the location of the school was not suitable. There was a lack of big ground at the school premises to conduct outdoor games and school prayers.

On the 8th of September 2019, I reached school C, to observe the classroom discourse of the assistant head-teacher named Kanchan (Pseudonym). It was one o’clock when I reached the school and it was a tiffin break in the school. I entered the assistant head-teacher’s cabin but he was not there. So, I waited for a while till he returned to the cabin. He entered the room talking and laughing with the next teacher. We discussed for a while about the school’s infrastructure, students' activities, problems faced by the teachers, students, etc. It was 1:20 pm and we went towards the classroom. The teacher had some paper-made and wood-made pyramid solid objects, a register, a mathematics book, board markers, and a whiteboard cleaner.

When we entered the classroom every student stood up and greeted us and we also greeted them. The teacher introduced me to the students and managed a seat on the last bench of the class. There were 45 students in the classroom and among them, 27 were boys and the rest of the students were girls. Referring to the register, I came to know that the students were from the communities of Tamang, Sherpa, Rai, Dhimal, Chaudhari, Bishwokarma, Chhetri-barman, Limbu, Newar,[8] etc. The classroom was diverse in terms of students from different communities. The classroom was rectangular with 16 sets of desks and benches. The space in the classroom was enough to carry the activities in the classroom. Also, a large part of the classroom was unused at the backside. Two large display boards were almost filled with works of literature in English, and Nepali; figures, and paintings; mathematical

[8] Some communities of Nepal, from Tamang to Newar.

works, and pictures. The teacher was going to teach a topic called “Prism and Pyramid” to class ten students.

Visual Discourse in Mathematics

Mathematics is a multimodal discourse in which mathematical texts use at least three different semiotic systems: verbal language, algebraic notations, and visual forms (Alshwaikh, 2008). In addition to the research that has been done on the verbal components of mathematical texts, tools need to be developed to describe the non-verbal components and investigate the role of mathematical visual representations in the construction of mathematical meaning. The diagram in mathematics is the abstract visualization to contextualize whereas concrete models or teaching materials or artefacts are the exact visual that holds a narrative structure. Mathematics is a cross-cultural phenomenon. Every culture has developed its mathematical system based on its daily needs. There are many mathematics ideas in the extracurricular environment if watched consciously. Observing cultural artefacts and the mathematical ideas embedded within them motivated and encouraged students to continue exploring mathematics (Pradhan, 2018). The study of mathematical ideas embedded in cultural artefacts helps create numerous opportunities to develop visually representative mathematical knowledge beyond the four walls of a classroom. A bangle, rubber band, tire, or tube of the bicycle is the visual representation of a circle. The concept of prism, pyramid, cylinder, cube, cuboid, sphere, hemisphere, triangle, quadrilaterals, etc. can be taught and clarified with the help of concrete visualization of models or cultural artefacts.

The connection with the daily activities and experiences of the students seems to be more appropriate. It is generally accepted that incorporating ethno-mathematical perspectives into school mathematics values students' cultural backgrounds and experiences. Observing mathematical ideas embedded in various cultural artefacts located in students' cultural contexts would motivate students to consider mathematics relevant to their lives outside of the classroom (Gould & Shah, 2018). Students build mathematical knowledge through their prior knowledge, experience, and active participation in their environmental activities. Children's cultural activities involve many implicit mathematical ideas.

Classroom Vignette 6: Teaching from Solid Figures

Teacher: *Yesterday we learned to calculate the area and volume of the prism and today I am going to teach you to calculate the area and volume of the pyramid. How many of you have heard about the pyramid?*

One of the boys: *Pyramid is the… um, thing in Egypt.* [Student replied uneasily.]

Next boy: *A pyramid is an artefact made by the Egyptian people thousands of years ago.*

Teacher: *Who else knows about the Pyramid?*

One of the girls: *The Egyptian people used to make a pyramid and put dead people inside it.*

Teacher: *Okay, Prayas, Heena, and … and what is your name?* [Pointing to the next boy who reacted to the teacher.]

Students: *Upendra,… Upendra sir.* [Choral Voice]

Teacher: *All of you, ..umm, Prayas, Upendra, and Heena. You are right.*

Students: [Silent]

Teacher: *A pyramid is a monumental structure with a square or triangular base and sloping sides that meet at a point at the top, especially one built of stone as a royal tomb in ancient Egypt. Their structure is like these objects. You share these pyramid-*

shaped objects in your groups and observe. [Showing the teacher made/collected pyramid-shaped teaching materials to the students.]

Students: [They passed these pyramid-shaped objects in their groups and observed.] *The pyramid seems to be like this.* [Few students reacted among themselves in the group.]

Teacher: [Teacher made a well-labelled figure of the pyramid on the whiteboard.] *Students listen to me carefully. Now, I am going to explain the basic concepts of the pyramid which helps you with numerical calculations.*

Students: [Everybody was aware of the teacher.]

Teacher: *A pyramid is a solid having a polygonal base and plane triangular faces meeting at a common vertex. The base of a pyramid may be any polygon, triangle, square, rectangle, hexagon, and so on. The length of the perpendicular drawn from the vertex to the base is called vertical height. If the vertical height falls at the centre of the base, the pyramid is known as the right pyramid.*

As shown in the figure, ABCD is the base of the pyramid. OAB, OBC, OCD, and OAD are triangular faces, O is the vertex, and OP which is perpendicular to the base is the vertical height. The height of a triangular face over its base is known as slant height. In this figure, OQ is the slant height of the face OBC.

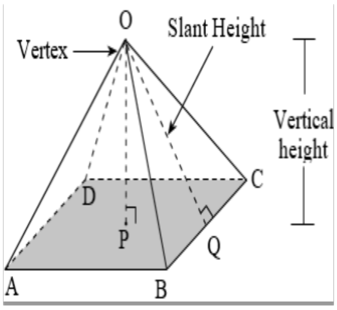


Figure 9. A Diagram of a Pyramid

[Teacher explained and wrote on the whiteboard]

Teacher: *Did you understand this?* [Showing on the whiteboard.]

Students: [Nodding affirmatively.]

Teacher: *Well, Satyaraj, you said, how many faces can you see in the square-based pyramid?*

Satyaraj: *There are... um there are …* [Student murmured incompleted sentence.]

A little boy: [Put a wood-made pyramid object on Satyaraj's hand.]

Satyaraj: [Quickly looked at the wood-made pyramid.] *Sir, there are five faces.*

Teacher: *Thank you, Satyaraj. Sit down.*

Teacher: *Sarita, now it's your turn. What are the triangular faces of the pyramid in this figure?* [Showing the figure on the whiteboard.]

Sarita: *The triangular faces of the pyramid are OAB, OBC, OCD, and OAD.*

Teacher: *Okay, very good. You sit down.*

Teacher: *After these basic concepts of the pyramid, I am going to derive the formulae to calculate the area and volume of the pyramid.* [The teacher erased the first picture and made another one.]

Let's consider a square-based pyramid with vertex O, then

Vertical height (OP) = h

Slant height (OQ) = l

Edge (OC) = e

Diagonal (AC) = d

Area of square (ABCD) = a × a = a^2

Area of a triangular face (OBC) = $\frac{1}{2}$ a×l = $\frac{1}{2}$ al

[Area of triangle = $\frac{1}{2}$ × base ×height]

Relation of the vertical height (h), side of the base (a), and slant height (l),

Slant height (l) = $\sqrt{h^2 + \frac{a^2}{4}}$

Vertical height (h) = $\sqrt{h^2 - \frac{a^2}{4}}$

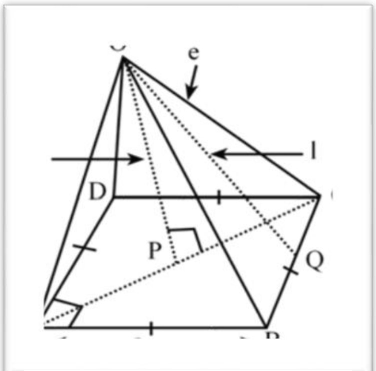


Figure 10. A Pyramid with Notation of its Dimensions

Length of side (a) = 2 $\sqrt{l^2 - h^2}$

Relation of the slant height (l), side of the base (a), and the edge of the triangular faces (e).

Slant height (l) = $\sqrt{e^2 - \frac{a^2}{4}}$

Side of base (a) = 2 $\sqrt{e^2 - l^2}$

Relation of the vertical height (h), length of the diagonal (d), and the edge of the triangular faces (e).

Vertical height (h) = $\sqrt{e^2 - \frac{d^2}{4}}$

Length of diagonal (d) = 2$\sqrt{e^2 - h^2}$

Length of a side of the base (a) = $\frac{d}{\sqrt{2}} = \sqrt{2(e^2 - h^2)}$

The volume of the square-based pyramid (v) = $\frac{1}{3}$ A× h [A = base area]

=$\frac{1}{3}$ a^2×h

The lateral surface area (triangular faces area) of the square-based pyramid

(LSA) = 4 × ($\frac{1}{2}$ al)

= 2al

The total surface area of a square-based pyramid (TSA) =4 × ($\frac{1}{2}$ al) + a^2

= 2al + a^2

Finally, the teacher told the students to memorize these formulae to calculate the lateral surface area, total surface area, and volume of the pyramid for the next day. The teacher explained the theoretical part of the pyramid by using teaching materials, and figures.

I observed that a boy could answer the teacher with the help of learning materials. From this activity, it was clear that teaching materials were useful for conceptualizing abstract geometrical shapes. Although there were interactions between teacher and students through questions-answers, and interactions among groups of students by using teaching materials, most of the time was elapsed in the explanation and derivation of formulae. The teacher explained the concept of the pyramid from the pre-knowledge of students. Although the pyramid was a great Egyptian cultural artefact, the teacher was unable to connect it with teaching, and with existing cultures in the Nepali context. During the question-answer, one of the girls said "*The Egyptian people used to make a pyramid and put dead people inside it"* but in this reply, the teacher could not connect it to our religious rites after the death of people in different cultures. In this context, Vygotsky's sociocultural theory (Vygotsky, 1978) argued that just as humans do not act directly on the physical world but rely, instead, on tools and labour activity, we also use symbolic tools, or signs, to meditate and regulate our relationships with others and with ourselves. Physical and symbolic tools are artefacts created by humans cultures over time and are made available to succeeding generations, which often modify these artefacts before passing them on to future generations such as music, art, language, and symbolic tools such as numbers, and arithmetic systems (Shabani, 2016). In Vygotsky's view, it is to be understood that physical tools and humans used symbolic artefacts to establish an indirect, or mediated, relationship between ourselves and the world organized through culturally constructed artefacts and social relationships.

From Vygotsky's sociocultural theory (1978), it was easy to understand that pyramids were cultural architecture /artefacts made by Egyptians. Now we have pagoda-style temples in our society as there are pyramids in Egyptian society. Pyramids consist of a square base and four inclined triangular faces meeting at the top likewise a temple in pagoda style consists of a square base and four faces of inclined trapeziums or triangles. These constructions are simple to complex mathematically designed architectures that symbolize human cultures and socially co-constructed knowledge which is often modified before passing on to future generations as indicated by Vygotsky. Pierre Bourdieu's famous cultural reproduction theory (Jæger, 2010) is that cultural capital, transferred over generations and possessed by family and individuals, is an important resource that contributes to individuals' educational success. This is how disparity is created. A family without the cultural capital that a school demands may experience failure. Cultural artefacts are the resources of knowledge that provide a positive effect on children's reading and mathematical understanding.

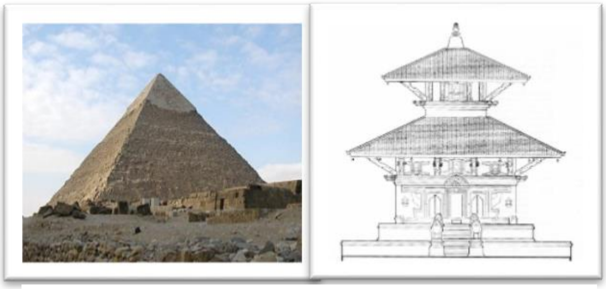


Figure 12. A Pyramid and a Temple

I was interested in observing a few classes with the same teacher to find out how the numerical parts related to the solid geometrical shape are taught to the students and how could students do the numerical part of that section. I requested the teacher to observe a few classes and the teacher easily replied "*You can observe any number of classes as you like*". I observed five classes continuously. The students fully participated in learning activities in the classroom. The teacher used enough local teaching materials made by himself and his students but I never saw the use of written lesson plans and teachers' guides. After presenting enough concepts of solid geometrical figures, the teacher divided the entire students of the class into eight groups, each group consisting of 6 or 7 students. These groups were named Group A to Group H. The teacher served each of the groups, pyramid, Cone, Cube, Cuboid, Prism, etc., and asked them to calculate the area and volume of the teaching materials that they got and rotationally the teaching materials were exchanged in the groups.

Learning Mathematics from Cultural Artefacts

Culture is a set of shared beliefs, values, customs, behaviours, and artefacts that members of a society use to cope with their world and with one another, while cultural artefacts are physical objects that are created by members of a culture and used to represent or symbolize aspects of that culture. Cultural artefacts are anything created and used by people of any race, region, and time and provide information about the culture of a particular group of people or society. The culture of its creators and users is encrypted in the cultural artefacts. For Nepalese people, who often go to the temple to worship God, Goddess, or deity, the worship behaviour is the culture, and the temple and idol in the temple are the cultural artefacts. Dancing by playing Madal or Damfu is culture, while Madal and Damfu are also cultural artefacts.

In the view of Antonietti and Colombo (2009), expand the definition of a work of art by introducing word sources to include any work of art that has the potential to enhance the teaching process. In this sense, Ezeife (2020) found that the extensive use of cultural artefacts makes school mathematics more meaningful. There are different types of cultural artefacts reflecting the cultural identity of different groups of people. Some of them are clothes, houses, furniture, paintings, designs, patterns, rangoli[9], statues, musical instruments, etc. For them, the cultural artefacts presented in mathematics lessons are solid materials that children often encounter in real-life situations. These solid materials can be useful tools for transferring knowledge from one area to another (Neel, 2005; Sharma & Orey, 2017). Cultural

[9] A cultural pattern made by mixtures of colours in the festival of Tihar. Tihar is the second largest festival in Nepal. This festival is also called festival of lights.

artefacts connect mathematical ideas embedded in the cultural works of people or tradition and their use as instructional tools to facilitate the teaching and learning of school mathematics more efficiently. In my observation, a mathematics teacher, Kanchan used different mathematical models and cultural artefacts to clarify the concept of cone, pyramid, and prism. Abstract mathematical concepts become visible from the mathematical modeling and students could solve model-related problems easily. A clip of the classroom discourse of Kanchan while teaching the concept of solid objects is presented here.

Classroom Vignette 7: Learning from Mathematical Modelling

Figure 13. A Clip of Students' Activities in the Mathematics Classroomm

Teacher: [Serving the solid figures in the groups]. *You need to find the area at first and then the volume of the given solids but you need to be sure that it is not necessary to hurry up. You need to discuss enough with the group members and then you proceed.*

One of the group members' boy: *Sir, do we have to do it individually or we can do it collectively because the area and volume of this cone are the same.*

Teacher: *You can do it individually, if you do so, you will have more practice.*

One of the girls in the group: *Can we measure the length in inches or centimeters?*

Teacher: *It is better if you measure it in centimeters.*

One of the girls of group F: *Sir, we um.. have a few problems. Can we get help from the next group members?*

Teacher: *Yes. You can.*

One of the boys from group C: *Sir, we finished.*

One of the girls from group F: *Oh, how fast? Wait, wait. We are also going to finish. Let's exchange our objects*. [They exchanged their objects.]

Teacher: *If you have any problems, please tell me.*

Students: [They were continuously doing their work and discussing in the group.]

One of the boys from group A: *Rejina, …Oye, Rejina.[*Rejina was in group C*]. What is your answer?*

Rejina: *Its area is 507.43 cm^2 and its volume is 617.98 cm^3*.

The boy: *…. but our answer is different from your answer.*

Rejina: *Sir, our answers to the same object are different. They [group A] got 507.43 cm^2 and 617.98 cm^3 but ours is 507.12 cm^2 and 616.93 cm^3. Whose is right?*

Teacher: [He collected exercise books from both groups A and C and investigated carefully]. *Students, listen carefully. You may have different answers group-wise and this may be due to the difference in your measurement as Group A and Group C. Group A students measured the length of the prism as 7.2cm but Group C students measured the length of the same prism as 7.3cm and this made the difference in your answers. Both groups have done well.*

In my observation, I found that students have actively participated in the teaching-learning process. They interacted with their group members and with the teachers to measure the dimensions of the given solid objects. The mixture of heterogeneous students based on their caste, religion, ability, gender, age, language, etc. collaboratively participated in learning activities. Some students seemed to participate more actively than others. I noticed that one boy was very active in measuring the dimensions of solid figures. Later, I interviewed him and found out that his family members were involved in woodworking and sometimes he was also involved in the work. The teacher acted as a facilitator in the classroom to teach the students practically. From this type of activity in the classroom, students learned the skills to differentiate and measure the dimensions of the solid objects, and thus obtained information was applied to the formula to calculate the areas and volumes of the respective solid objects.

In this perspective, Vygotsky's (1978, p. 86) ZPD was found applicable and found to be used in classroom activities which states that the distance between the actual development as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance, or in collaboration with more capable peers can make significance in learning. Furthermore, McLeod (2019) adds social interactions with a skillful tutor that allow the learner to observe and practice their skills meaningfully and scaffolding, or supportive activities provided by the educator, or more competent peer, to support the student as he or she is led through the ZPD. In the classroom activities, there were enough social interactions and some students played the role of supportive peers to the low-learner or less competent students. The teacher played the role of a more competent agent and collaborative environment creator. From a Vygotskian Perspective, the teacher's role was to meditate on the child's learning activity as they shared knowledge through social interactions.

In the group work, some students were seen as interested in the observation of given materials and the measurement of dimensions of the given solid materials, some of the students were keenly interested in drawing the figure, and some were interested in problem-solving or calculation. Some students could directly interact with the teacher and another group of students openly but some hesitated or denied it. In this context, Gardner (2011) suggests there are “candidate” intelligence – logical/mathematical, linguistic, musical, spiritual, bodily-kinaesthetic, naturalist, interpersonal, and intrapersonal intelligence. Gardner defines intelligence as a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture (Gardner, 2000, p. 28). Hence, both Vygotsky’s theory of socio-culture and Gardener’s theory of multiple intelligence exist and were applied in Nepali Mathematics classroom discourse.

Mathematics is everywhere and embedded in cultural architects and artefacts in our local areas and everyday used types of equipment that cannot be ignored from the lens of mathematicians. Culturally contextualized mathematics may help students connect school mathematics with their own home cultures by elaborating on ethno-models (Trouche, Gueudet, & Pepin, 2018). The theoretical basis of ethnomathematics and culturally relevant pedagogy can be an appropriate response for mathematics education in Nepal connecting with their community and cultural practices to make mathematics meaningful for students (Sharma & Orey, 2017). Within this context, D’Ambrosio (1993) affirms that culture considerably affects how people understand mathematical ideas, procedures, and practices. Hence, ethnomathematics has demonstrated how mathematics is made of many diverse and distinct cultural traditions because each cultural group has developed unique ways of incorporating mathematical knowledge and has often come to given cultural systems, especially in ways that members of cultural groups quantify and use numbers, incorporate geometric forms and relationships, and measure and classify objects

(Sharma & Orey, 2017). Cultural artefacts are objects created by the members of cultural groups, which give cultural clues and information about the culture of their creators and users (D'Ambrosio, 1993). In this regard, these artefacts are made to adorn walls, ceilings, baskets, utensils, clothes, jewellery, and even the human body itself as well as to serve religious purposes (Sharma & Orey, 2017).

As the child takes birth, s/he grows up with the surrounding materials of his/her habitat, e.g., a Nepali villager grows up by seeing and playing with *the Janto*[10], *Dhiki*[11], *Nanglo*[12], *Dhungro*[13], *Kutto-kodalo*[14], *Pani-Ghatta*[15], *Ghum*[16], *Gundri*[17], *Halo-juwa*[18], *Ranbo*[19], etc. and if these objects are included in the school curriculum then s/he easily contextualizes the cultural artefacts because there is no difference in between home context and school context, otherwise, the school context becomes strange for learning. The ways of construction and use of cultural artefacts have gradually transformed into technologically easier, more advanced modifications, and are the threat of disappearance from our community. Our *Janto*

Figure 14. AClip of Ancient and Modern Measuring Tools

[10] A circular stone tool used for grinding grains.
[11] A tool used for beating grains.
[12] A circular tool used for separating husk from grains.
[13] A bucket like tool made for putting milk.
[14] A tool used for digging field.
[15] A water mill for grinding grains.
[16] A cave-type tool used instead of umbrella.
[17] A big mat made from straw of rice plant
[18] Tools made from wood to plough the field with the help of oxen.
[19] A Nepali word used for chisel.
All the tools used here represent the mathematical shapes of circle, cylinder, squares, rectangles, etc.

and *Pani-ghatta* are being replaced by an electrical mixture, *Tulo*[20] by digital balance, *Ghum* by an umbrella, *Gundri* by carpets, earthen pottery, *Theki*, *Harpe*, *Dhungro*, etc. by plastic containers. We have varieties of local *Jatras*[21], cultural dances, and songs, connecting with religious beliefs, historical realities, and experiences of old people. By connecting these socio-cultural activities with mathematics pedagogy and, if possible, integrating them into the curriculum, the mathematical contextualization of learners can be improved and permanently imprinted in them. This is the transformation of mathematical knowledge from sociocultural to technological and it is the dominance of local knowledge by scientific and technological knowledge. In this regard, Sharma, Sharman, and Orey (2020) state that children started learning about Christmas and forgetting about *Machindranath*. Celebrating our own cultures and traditions became equated to backwardness. Similarly, Shrestha (1997) outlines that when development arrived, farmers who owned several cows and plots of land became *poor,* and people who learned English and had big houses were called *rich*. Similarly, the person who speaks English became superior and the local language speakers became inferior to them."

Culturally relevant pedagogy uses cultural knowledge, prior experiences, frames of reference, and unique learning styles of ethnically diverse students to make learning more relevant and effective with the objective of strengthening their connectedness with schools and as a consequence reducing behaviour problems and enhancing learning (Klotz, 1991). Nepal has very little research in ethno-mathematics and pedagogical practices that are suitable for our climate, in turn, the pedagogical practices are individual teacher-based, euro-centric, and deductive. In this context,

[20] A tool used for measuring weight.
[21] Local festivals celebrated by Newar ethnicity.

Sharma and Neupane (2016) emphasize the use of cultural project-based learning (CPBL), and it has been taken as an alternative way to empower learners by engaging them in socially and culturally authentic problems and projects to understand the mathematics that used to be taught in isolation. CPBL is not possible unless teachers are empowered to understand the notion of education as a political act. By applying ethno-pedagogy in mathematics, (Acharya, 2012, 2017; Flavell, 1979; Hacker et al., 2009; Luitel, 2009, 2013; Sharma & Neupane, 2016; Rosa & Orey, 2013; Sharma & Neupane, 2014), a good learning environment would be created within the periphery of historical-cultural activity-based, cultural art-based, local-teaching material-based, and local-global-methodological based education that expands the socio-cultural identity, religious beliefs, and cultural intelligence of both teachers and students. The Western education system and pedagogy were introduced and advanced within the numerous research in their sociocultural underpinnings and we applied it, which resulted beneficially, although we have to modify it to integrate our situation.

Students always learn from visualized objects rather than abstract things, therefore, cultural artefacts and local teaching materials are seminal in pedagogic activities. Scaffolding strategies become one of the most powerful techniques to empower students in the multicultural education system because everyone is a knower of his/her cultural experience but none of them is a knower of every other's cultural experience. In this context, Vygotsky (1978) states that learners' thoughts and actions evolve from interacting with their sociocultural background, and Dewey (1966) adds to it, stating that knowledge is formed when humans actively interact with their environment.

Mathematics of Nepali National Flag

Kanchan sir's next class was intended to teach the calculation of the area of a scalene triangle. He first, made a figure of the scalene triangle on the whiteboard and explained its angles, sides, and its relations. He explained the concept of perimeters, semi-perimeters, and area and methods to calculate them.

Classroom Vignette 8: Teaching the Calculation of Area of Scalene Triangle

Teacher: *What is the scalene triangle?*

One of the boys: (Raising his hand), *Sir, can I say?*

Teacher: *Oh, Rajan. Okay.*

Rajan: *The triangle having unequal angles is a scalene triangle.*

Teacher: Anyone?

Rushma: A *Triangle having unequal sides is a scalene triangle.*

Teacher: *Okay. Thank you. Both of you sit down.*

Teacher: *The triangle having unequal angles and sides as well is called a scalene triangle. In this class, I teach you to calculate the area of a scalene triangle by using sides.* (The teacher made a labeled diagram of the scalene triangle on the whiteboard.)

Teacher: (Showing the diagram), *this ABC is a scalene triangle.*

Its sides are a, b, and c respectively.

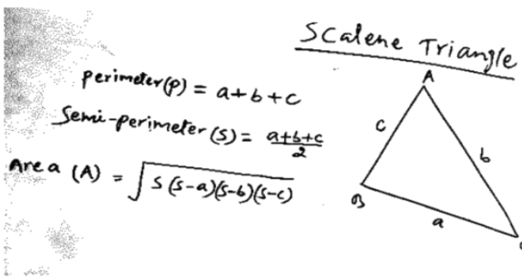


Figure 15. A Clip of Teacher's Writing on the White Board

Teacher: *Can anybody tell me how to find the perimeter of this triangle?*

Sushi: *The sum of sides.* (Sitting.)

Kriti: (Stood up and said). *Perimeter is the sum of sides a, b, and c of triangle ABC.*

Teacher: *Good. Thank you, Kriti. You sit down.*

Teacher: *Did you know? What did Kriti say?*

Student: *Yes, Yes sir.*

Teacher: *Pritam, can you tell me what the perimeter is?*

Pritam: (Stood up and said.) *Yes sir. Perimeter is the sum of all sides of a triangle ABC.*

Teacher: *Okay. You sit down.*

Teacher: *Perimeter is calculated as* $P = a + b + c$.

Semi-perimeter is half of the perimeter and calculated as, $S = \frac{a+b+c}{2}$

and area is calculated as, $A = \sqrt{(S\ (S-a)(S-b)(S-c)}.$

After writing the formulae, the teacher assigned the sides of a triangle with numerical values and calculated the area of a scalene triangle with an explanation. Then the teacher asked his students to construct a scalene triangle on their exercise book, measure the side individually, and calculate the area. Many of the students completed their work easily and quickly but a few students had confused about it. The confusion was resolved by the classmates and teachers. As a project work, teachers suggested constructing a scalene triangle with sticks, toothpicks, and straws and calculating their area. He also suggested his students make a national flag of our country and calculate its area of it.

I found that classroom activities were meaningful in calculating the area of a scalene triangle. Most of the students succeeded in constructing a scalene triangle, measuring the sides, and calculating the area of a scalene triangle. The project work was given to construct a triangle with their household materials. I was very impressed with the project work concerning the national flag because it connected students with our culture of making a national flag and the area of the triangle. I was excited to see how the students made the national flag and calculated its area. I requested Kanchan sir to observe another class. He accepted my request. Many students made attractive national flags and calculated their area.

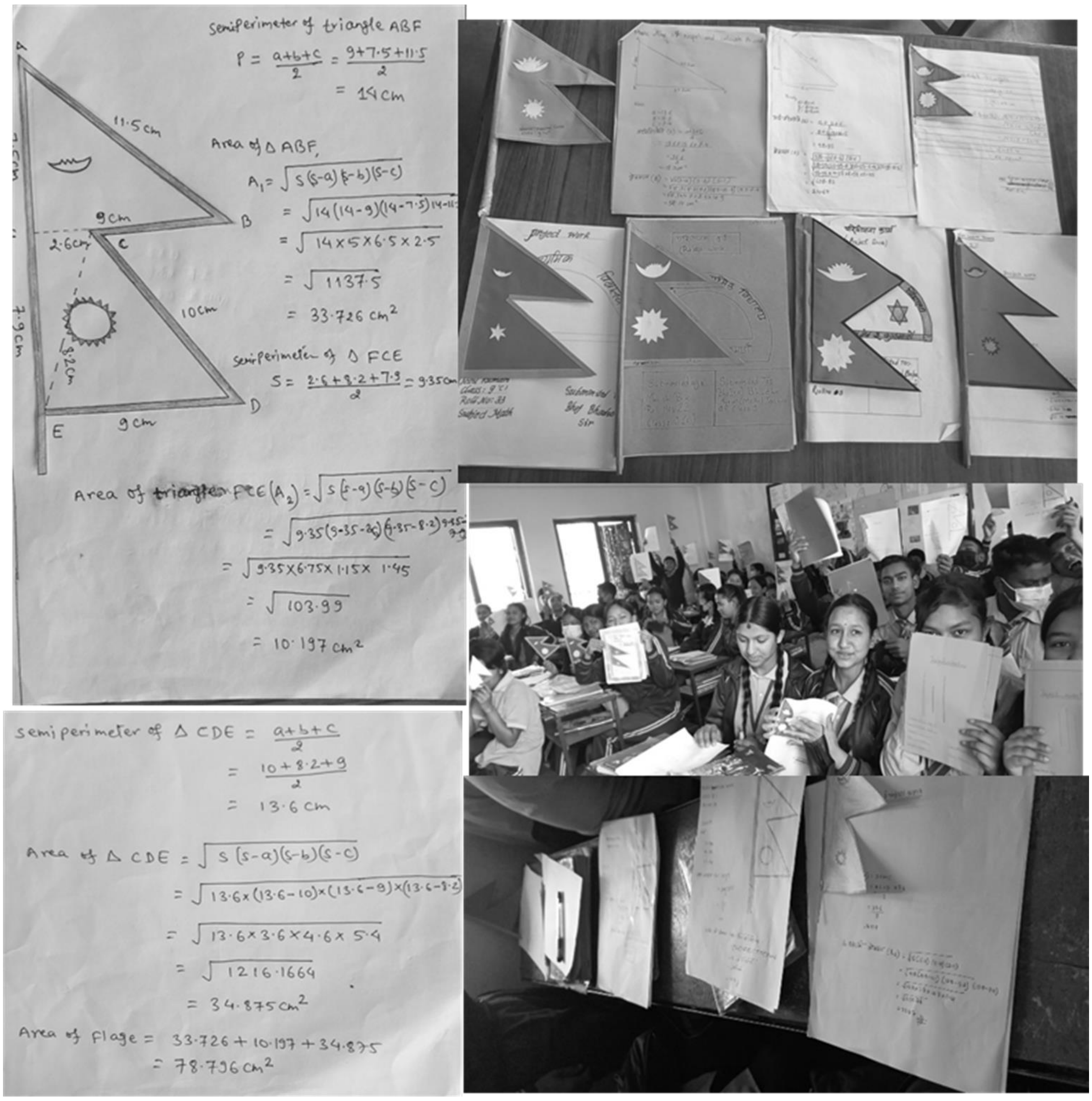


Figure 16. Students Involving in the Calculation of Area of National Flag

Nepal is a landlocked central Himalayan country in South Asia. Its flag is the world’s only non-quadrilateral national flag. The national flag of Nepal consists of two juxtaposed triangular figures with a crimson-coloured base and deep blue borders, there is a white emblem of the crescent moon with eight rays visible out of sixteen in the upper part and a white emblem of a twelve-rayed sun in the lower part (The constitution of Nepal, 2015). The national flag of Nepal is interpreted differently at different time intervals. It is based on two different pennants that belonged to rival

Figure 17. Evolution of National Flag of Nepal

branches of the Rana dynasty, which ruled the country before. The two pennants were first joined in the 20th century. Until 1962, the flag's emblems, the sun, and the crescent moon had human faces, but they were removed to modernize the flag. The current flag was adopted on 16 December 1962, along with the formation of a new constitutional government (The Flag of Nepal, 2020, August 21). The moon in the upper portion stands for the royal house. The sun in the lower section symbolizes a branch of the Rana family, members of which were prime ministers until 1961. The style of these heavenly bodies was streamlined on 16th December 1962. The coat of arms still portrays these changes along with facial features. Crimson is deemed as the national colour of Nepal. The motto on their coat of arms is "*The Mother and the Mother Earth are more important than the heavenly kingdom"* (The history behind the flag of Nepal, 2020, August 21).

In modern times, the concept of the flag has changed to have a different meaning. According to Britannica (2020, August, 21), Wikipedia (2020, August, 21), and the constitution of Nepal (2015), the blue border symbolizes peace and harmony. The crimson red is Nepal's national colour and reflects the brave spirit of the Nepalese people. The two triangles symbolize the mountains. The depiction of celestial bodies represents permanence and the hope that Nepal will last as long as the sun and the moon. The moon symbolizes that the Nepalese are calm, while the sun symbolizes fierceness. The moon also symbolizes the pleasant weather of the Himalayas, whereas the sun symbolizes the heat and the higher temperatures in the lower-lying areas of Nepal

The construction of the Nepali flag is the perfect mathematical work and students are seen as fond of making Nepali national flags in different subjects. If the teachers tell them, that the flag has mathematical, historical, and cultural connections then the learners contextualize the mathematics. The making of the Nepali national flag consists of complex circles, arches, triangles, and straight lines, which is the perfect geometrical work. This calculation of aspect ratio is complex arithmetic work. It means I do not claim that everybody should know this complex mathematical work but if the teacher focuses on the simple concept of straight lines, triangles, measure of angles, calculation of height-width ratio, and area, then learners can connect the mathematics with their national flag. Likewise, our national flag is mathematical, and every sociocultural artefact is laden with mathematical concepts. The teachers should suggest their learners visualize mathematics in everything around them. This kind of behaviour can help to contextualize mathematics other than only from textbooks.

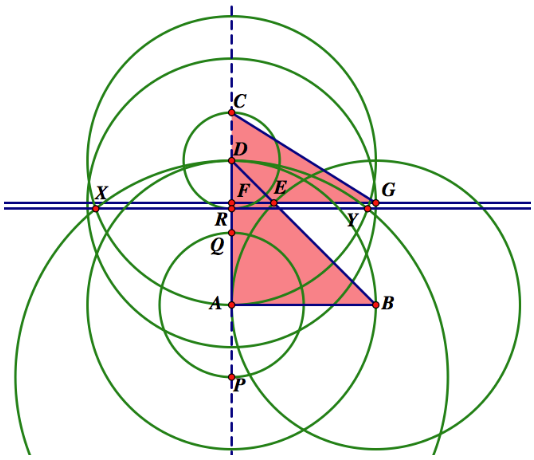


Figure 18. Process of making Flag of Nepal

In this context, Bourdieu (1986) argues that capital, which, in its objectified or embodied forms, takes time to accumulate and which, represents the immanent structure of the social world, i.e, the set of constraints, inscribed in the very reality of that world, which durably governs its functioning, determining the chances of success for practices in technical education.

Use of Local Objects on Mathematics Discourse

After the observations of four classes, I requested Kanchan sir to talk to me regarding classroom activities connecting to existing cultures. He easily accepted my request. We sat together in his office with coffee and snacks for an hour. We talked formally and informally relating to different problems and their solutions.

Figure 19. Concrete Figures Prepared by the Mathematics Teacher before Starting the Classroom Discourse

BB: *In my observation, you always used teaching materials and students participated fully in classroom activities. These are the positive sides, what are the negative sides of pedagogical discourse in mathematics classrooms in your experience?*

Kanchan: *There are a lot of problems in our classrooms. The biggest problem is that most of the students of this school are not from the local area. They are from different districts. They have different learning styles and cognition levels. It is not easy to teach them to maintain equity but I try my best. I like to teach with teaching materials and students also support teaching with materials. I think teaching by making small groups of students helps them familiarize new students with each other and they become habitual to working collaboratively with others. It also helps to mix in intercultural connections.*

BB: How do you understand multiculturism?

Kanchan: In my understanding, multiculturalism is the recognition, acceptance, and celebration of the cultural diversity that exists within communities, societies, and *nations. It is the idea that all people of different backgrounds, beliefs, and values should be respected and accepted. It also involves the celebration of different cultures and the recognition of their contributions to society.*

BB: *How can this culture be integrated into mathematics discourse?*

Kanchan: *One way to integrate culture into mathematical discourse is to use examples that are relevant to students' everyday lives and experiences. For example, if discussing the concept of perimeter, one could use examples that relate to the student's culture, such as the perimeter of a traditional house from their culture, or the perimeter of a structure from a local cultural event. Additionally, when discussing mathematical concepts, it can be useful to include stories from the student's culture as a way to explain the concept. This can help to make the concepts more accessible and relatable for the student. Next, the use of mathematical artefacts that come from different cultures also helps to integrate existing cultures into mathematics. Adding the cultural activities such as "rekhi" made by Brahmin in "yagya" or "hom" can include triangles and quadrilaterals, making "china" in some societies are also mathematical work.*

Figure 20. Ritual Rekhi of Yagya

BB: *Well, the students are from different districts with diversities. In this situation, is it possible to maintain multicultural education in mathematics teaching?*

Kanchan: *[Hahaha, laughed for a while.], Of course not. Our classrooms are surely multicultural; there is no doubt about it. However, truly speaking, we do not have* *enough training, curriculums, textbooks, and experiences of multiculturalism in the mathematics classroom. Despite these hindrances, every teacher and student respects each other's religions, festivals, and languages. There is no discrimination in castes, religions, and genders.*

In conversation with Mr. Kanchan, I realized that our classrooms reflect a small society as students from different communities with different castes, religions, varying socio-economic statuses and abilities gather in the same classroom. Hence, it is more challenging to run a math class smoothly. Mathematics teachers tend to divide students into small groups, thinking that it is easier to conduct the class and that cross-cultural activities can be shared between group members. In the teachers' understanding, acceptance, recognition, respect, and celebration of their beliefs, and values are the culture in mathematics discourse. Cultural integration in mathematics discourse refers to the use of individual students' daily activities in mathematics discourse and providing students with sufficient examples to develop a clear understanding of mathematics content. The teacher used teaching materials as much as possible in his classroom teaching mathematics. He also provided more time for group discussions and interactions of students thinking that these types of activities help to mix new students to intercultural connections. Multiculturalism was not followed in the classroom knowingly but unknowingly they were doing multicultural activities and students and teachers respect it. In this regard, Bennett (2012), Gay (2000), Gorski (2010), and Halvorsen and Wilson (2010), argue the same standpoint that students and teachers respect each other’s culture either knowingly or unknowingly in a democratic society and this activity reduced ethnocentric attitudes and stereotypes by creating equal education opportunities for all students regardless of racial, ethnic, class, and cultural backgrounds, effectively relating social issues of race, ethnicity, and culture to the educational process.

Multiculturalism in mathematics discourse is the idea that students should be exposed to different cultures and backgrounds when discussing and learning mathematics. This means engaging students in conversations and activities that connect mathematics to their own cultural contexts and experiences (Mahat, 2019). It includes recognizing the range of different perspectives on mathematics that exist among different cultures and honouring the diverse ways of thinking about, doing, and teaching mathematics.

Every society or group of people has unique life skills, traditions, and cultural artefacts. Everyday practices of society can encrypt the mathematical knowledge from many generations (Hodson, 2001), such as the roof of a house, *Dhungro, Doko, Dalo, Halo, Juwa, Kodalo, weaving Ghum, Gundri*, ornaments, sculpture, etc. In Nepalese culture, people use *Doko* to transport various crops, goods, and other things. If we look at the image of *Doko*, we can see the mathematical symbolic representation, various geometric shapes, and lines such as parallel lines, intersecting lines, angles, triangles, opposite angles, quadrilaterals, circles, etc. Some straight lines and curved lines exist between these different lines, some of them appear parallel while some intersect each other (Rijal, 2021). There, we can see different vertical and horizontal lines. In addition, we can see various geometric shapes such as triangles, squares, and various regular and irregular polygons. These cultural activities connect mathematical

Figure 21. A Doko

concepts of lines, parallel lines, intersecting lines, angles, triangles, quadrilaterals, and many more. If we incorporate these cultural activities into our mathematics curriculum, textbooks, and teaching materials; students can learn geometrical concepts easily.

It is also a kind of policy or practice to bring together all different or diverse cultural groups, especially minority cultural groups who have experienced oppression and are excluded from the mainstream of society. In such a scenario, the introduction of the multicultural dimension in education can be seen as a very essential work that seeks to make mathematics culturally responsive and inclusive. Therefore, incorporating mathematics education into ethnomathematics education will not only clarify the content for students, but also help them to understand, respect, and appreciate other cultures for their contribution to society, and they will also be proud of their own culture (Mahat, 2019). By using various cultural materials, artefacts, stories, and more, we can make the mathematics teaching and learning environment interesting and meaningful for students. Therefore, incorporating ethnomathematics into the teaching and learning of academic mathematics not only provides students with an opportunity to understand diverse mathematical content but also helps them see how our own cultures have contributed to the development of mathematics.

In my interview with selected students, they responded differently according to their experiences of the classroom discourse in mathematics. They openly talked to me about their feeling toward mathematics teaching. They even shared their perspectives regarding the personal problems faced in their families and low socioeconomic problems. However, I found that students were positive toward school management and classroom activities.

BB: *How do you feel about learning mathematics and what are the problems?*

Sarita: *I think it is okay. It is easier for me because our mathematics teacher focuses on more discussions, interactions between students, explanations, presentations, preparing learning models, and group work among students.*

Rabi: *I feel mathematics is a little bit harder because the school I used to study in the village did not teach mathematics well. Here is a good way to teach us individually and in small groups. Friends in the group also teach what I do not understand in the classroom. I am improving now.*

John: *I find mathematics difficult because I had no habit to do homework and revise mathematics frequently in earlier classes. The good teaching style, motivation, and group work have encouraged me to learn.*

Yashika: *At first, I used to get angry when I think about mathematics. I like to learn now with the help of teachers and friends.*

BB: Do you think your mathematics teacher reproduces your existing culture in mathematics discourse?

Sarita: Not in all chapters but if the teacher wants us to focus more to understand more, they use more examples from daily life like they use bangles, rubber bands, hair bands, chalno, mundri, rings, bicycle tubes, etc. to represent a circle.

Rabi: Yes, they do. I remember recently our math teacher was teaching cylinders. In his discourse, he used to ask us what kind of things like cylinders are used in our homes. In response to his question, the students answered dhungro, harpe, theki, pipe, pencil, maani (Buddhist prayer wheel), madal, dholaki, drum, cell, candle, haato, okhal, shivalinga, mushal, bansuri, etc. I think some of these came from our culture.

John: While teaching triangles, squares, rectangles, and parallelograms in geometry, teachers use many examples for easy understanding from doors, windows, photo *frames, chess boards, napkins, house walls, ceilings, ornaments, etc. This makes it easy to conceptualize the contents.*

Yashika: In my view, the culture in mathematical discourse is to encourage questioning, debate, and collaboration. Through this, there is an exchange of lifestyles between students representing different communities. Respect students' backgrounds and perspectives. Respect the language, religion, and caste of all students. Mathematics teacher does all things while teaching in the classroom.

From the students' interviews, it was clear that they (students) liked to learn in small groups. Students appreciated the teaching style of the teacher focusing on discussions, interactions between students, explanations, presentations, preparation learning models, and group works among students. Students said that they were improving mathematics learning with the collaborative and collective effort of the teacher and their colleagues in the classroom. It was an effective talk about their culture not only inside the classroom but outside as well. One way to reproduce individual culture in mathematics discourse is to incorporate cultural references, symbols, and stories into math lessons. For example, a teacher can use stories from their own culture to demonstrate a mathematical concept or use symbols from their culture to illustrate a mathematical problem.

In addition, teachers can incorporate cultural music and art into their lessons as visual aids or to provide a break from class instruction. Furthermore, teachers can incorporate cultural perspectives into their mathematics discourse and encourage students to discuss the cultural implications of their work. Besides, McLaren (1994) says that learning is not only alien to their reality but may also be antagonistic to their culture and lived experiences – that is their capital. The term cultural capital used by Bourdieu and Passeron (1973) is described as being the general cultural background, knowledge, disposition, and skills that are passed on from one generation to another. Cultural capital represents ways of talking, acting, and socializing, as well as language practices, values, and types of dress and behaviour. The teaching materials made by wood-carving are also a part of our culture. Teaching materials to teach mathematics is the capital. Therefore, cultural capital is connected to every action of the people.

The preparation of students to be functional in a competitive, pluralistic society, and teaching them mathematics connecting their customs, heritage, history, and other aesthetic aspects are essential components of an effective education program, termed multicultural mathematics education (Banks, 1989). Multicultural education is a transformative movement in education that produces critically thinking, socially active members of society. It is not simply a change of curriculum or the addition of an activity. It is a movement that calls for new attitudes, new approaches, and a new dedication to laying the foundation for the transformation of society (Gorski, 2001, p. 1). Banks (1999) also stated a similar view that multicultural education is an idea, an educational reform movement, and a process whose major goal is to change the structure of educational institutions so that male and female students, exceptional students, and students who are members of diverse, racial, ethnic and cultural groups will have an equal chance to achieve academically in school. Furthermore, Banks (1994, 1997) suggested five components required for ensuring a multicultural education are – content integration, the knowledge construction process, prejudice reduction, equity pedagogy, and empowering school culture and social culture (Tarman & Tarman, 2011).

Content integration identifies diverse cultural contributions to mathematics. Mostly, non-European students think that mathematics is Eurocentric and is useless and powerless to other communities and suffer from mathematics anxiety. In the same vein, Marilyn (1995) suggests that to overcome this type of thinking, content integration, especially linking mathematics to different ethnic groups, nationalities, and genders can help students from diverse cultures overcome some of their fears and negative attitudes towards mathematics Knowledge construction: In mathematics classes, teachers can help students understand that even though certain elements of mathematics are universal such as counting, locating, measuring, designing, playing, and explaining. For example, early-grade students are taught to count on fingers, pebbles, sticks, etc. according to their existing culture.

In knowledge construction first, we put positive attitudes toward different cultural groups that can be encouraged by using mathematics to study social or cultural issues. Multicultural literature can not only help with content integration but can also help with prejudice reduction by depicting what is unique to a specific culture and what is universal to all cultures (Marilyn, 1995). By portraying the nuances and variety of day-to-day living, multicultural literature presents a true picture of the culture it reflects (Bishop, 1992). Our day-to-day activities like *Thanka*[22] painting, cooking food in the kitchen, using clocks and calendars, playing games, etc. all are mathematical works.

Equitable pedagogy is a discourse between teachers and students and requires mutual respect for culture, not just in terms of historical contributions and artefacts, but also in every aspect of instruction. Ladson-Billings (1990) claims that teachers help students make connections between their community, national, ethnic, and global identities. Banks (1989) argues that teacher-student relationships are fluid, humane,

[22] *Thanka*: Tamang, Sherpa and Gurung tribes of Nepal and Tibetan traditional painting. It is one of the original forms of Nepali handicrafts.

and equitable, and extend beyond the classroom into the community. Teachers encourage students to learn collaboratively, students are expected to teach each other and be responsible for each other in the learning activities.

Role of the Home in Empowering Culture in Mathematics Learning

A student's education starts from our home. Students can learn a lot from their elders. Students learn to communicate in their mother tongue, count, paint, cook, play, and many other things from their homes. If it is oriented to teach mathematical knowledge encrypted in our daily activities, it is a great opportunity to learn mathematics from home. A house may contain a variety of mathematical artefacts such as circular tables indicating a circle, doors, and windows showing rectangles and squares, and various structures and patterns that indicate transformations. Naresh (2015) realizes that it is important to empower students, by broadening, not narrowing their knowledge of mathematics; by inspiring their participation and creativity in contributing to the development of mathematical knowledge, and, for teachers, through the creation of culturally responsive teaching.

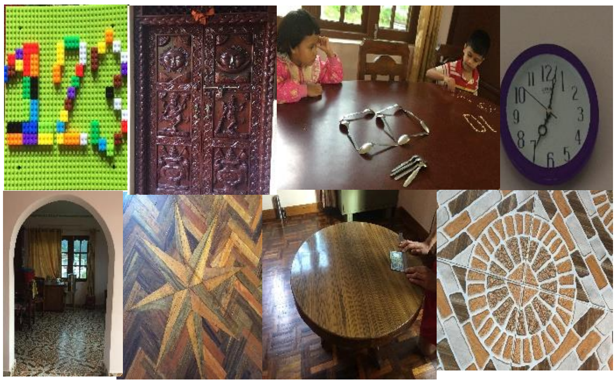


Figure 22. Cultural Artefacts in Homes of Nepalese People

Ethnomathematics and ethno-pedagogy incorporate the teaching of mathematics interconnecting with sociocultural realities, life skills, religious beliefs, and cultural and social artefacts scattered in our societies. Teaching mathematics from our kitchen works is interesting, skillful, and supportive to parents. Mathematics shows up in many aspects of cooking and baking, including converting temperature from Celsius to Fahrenheit and vice versa, changing the quantities of ingredients provided by a recipe, and working out cooking times based on weight. Cooking with children not only encourages healthy food habits and valuable life skills, but they also learn basic math concepts such as measurements, fractions, and counting. The simple task of setting the table offers myriad opportunities to strengthen mathematics concepts. Ask the child to count out the appropriate number of plates, glasses, and cups. Children of different ages are fond of playing with cereals, clay, cubes, dice, coins, paper notes, kitchen tools, etc. and if teachers/parents teach them to connect these available things inside the homes with mathematical work of counting, measuring, comparing, making patterns, finding areas, perimeters, etc., then mathematics is visually contextualized.

Unseen and abstract mathematics can be visualized in their day-to-day works in their socio-cultural backgrounds. Finding the perimeter, area, aspect ratio, weight, etc. from the coins and paper currencies by measuring the dimensions may be cultural and mathematical work in the students' own existing identities and realities. Children can measure the dimensions of doors, windows, tables, cupboards, textbooks, clocks, rooms, etc., and can quantify them. Researchers, educators, curriculum planners, administrators, and teachers as well as those working in the mathematical fields should be aware and play an important role in incorporating these things into the mathematics curriculum. Teachers should provide such skillful tasks in the project work and/or assessment works.

Culture begins at home and unwritten rules, social norms, and patterns of behaviour in all homes can be much more difficult to change than in school. (Prechard, 2014). Students gather in the school from different homes with individual cultures, therefore, the classrooms are multicultural. However, the school cannot provide multicultural education, it is only possible through the combined effort of students, teachers, and parents. Multicultural education in mathematics, equity, and equality is possible only when teachers motivate the students to learn from their homes.

Classroom Discourse from School D

I went to school D on Tuesday, 4th February 2020, for the first time. The school was nearby the main road and it has a large old-fashioned two-storied building. The school had enough open space outside of the building. The open space was enough for the outdoor games, school prayer, and other mass activities of the school. There was a circular, very beautiful public garden on the next side of the road, which was visible from the top of the school building. This school was established in 2012 BS and is located at Tangal, nearby Nagpokhari. This school was the resource centre for other schools located at its periphery. A few students were playing on the school premises and I asked them for the head-teacher's office. I followed the way pointed out by one of the students and reached the head-teacher's office. There I met the lady head-teacher in her office. I introduced myself and my objective to be there. We talked about students, teachers, and contemporary education policy and its impact on running the school, for a while. Then, she introduced me with two mathematics teachers and suggested collaborating and working with them. The head-teacher also promised to help me from her side as well as the school's side, as required. I talked with mathematics teachers and made a schedule to observe a few classes on the feasibility of their class routine and time.

On the next day, 6th February 2020, I went to the school to observe one of the classes of a mathematics teacher, Gomden, who was teaching grade ten. Before going to the class, we talked about our personal information, including school service, opportunities, problems, etc. At 11: 30 a.m., we went to the classroom. He introduced me to the students. Students greeted and welcomed me in their classrooms. The classroom was very clean, wide, and well-managed. There was a big whiteboard and a display board, which was filled with Nepali poems and jokes written by students. Mr. Gomden was going to teach the area of triangles.

Classroom vignette 9: Teaching Area of Triangles

Teacher: *Do you know how to find the area of a triangle?*

A boy: *What kind of a triangle, sir?*

A girl: *Is it an equilateral triangle, sir? If it is, I know.*

Teacher: *Okay, tell me, Kabita. How do you calculate the area of an equilateral triangle?*

Kabita: *The area of an equilateral triangle is equal to* $\frac{\sqrt{3}}{4}a^2$.

Next girl: *What is this* a^2*?*

Kabita: *Umm,…*

Teacher: *Kabita, your friend wants to know about* a^2*. Do you know what is it?*

Kabita: *No idea, sir.*

Teacher: *Who knows what this a2 is?*

Students: *[Silent.]*

Teacher: *What is called an equilateral triangle?*

Students: *The triangle which has all equal sides...angles.* [Choral Voice.]

Teacher: *The equal side is "a" and the square of the equal side is* a^2.

Student: [Silent.]

Teacher: [Draws a well-labeled figure of a triangle on the whiteboard.], *PQR is the triangle with base* $QR = b$ *and altitude (height)* $PS = h$, *Then the area of* $\Delta PQR = \frac{1}{2}$ *base × height*

$$= \frac{1}{2} QR \times PS$$

$$= \frac{1}{2} .b. h$$

Therefore, the area of $\Delta = \frac{1}{2}$ *base × height*

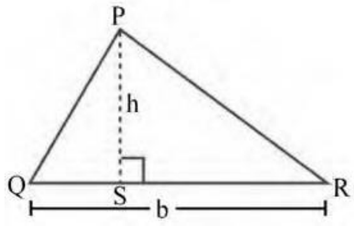


Figure 23. Triangle Showing Dimensons

A boy: *Sir, what is this small triangle called?*

Next boy: *You don't know? This is the symbol of the triangle.*

Teacher: *Yes. This is the symbol of the triangle and it represents the area of the triangle.*

Teacher: *Now, I am going to derive the formula to calculate the area of an equilateral triangle. Please keep quiet and pay attention to the board.*

Let us find the relation between the sides and the area of an equilateral triangle. The triangle ABC is an equilateral triangle in which AB = BC = AC.

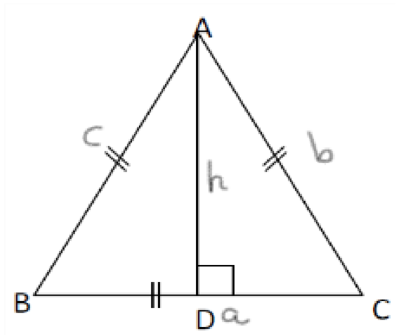


Figure 24. An Equilateral Triangle

A line AD is drawn by joining the mid-point 'D' of the base BC and vertex 'A'. So, AD is perpendicular to the base BC. AD is also the height of ΔABC.

Let AB = BC = AC = a unit and AD = h unit. Then, BD = DC = $\frac{a}{2}$ *unit.*

Now, in the right-angled triangle ADC,

$(\text{Hypotenuse})^2 = (\text{base})^2 + (\text{perpendicular})^2$

Or, $(AC)^2 = (DC)^2 + (AD)^2$

Or, $a^2 = (\frac{a}{2})^2 + h^2$

Or, $a^2 = \frac{a^2}{4} + h^2$

Or, $a^2 - \frac{a^2}{4} = h^2$

Or, $\frac{3a^2}{4} = h^2$

$h = \frac{\sqrt{3}\,a}{2}$ *units.*

We know that the area of the triangle = $\frac{1}{2} \times$ *base* $\times$ *height*

$$= \frac{1}{2} \times BC \times AD$$

$$= \frac{1}{2} \times a \times h$$

$$= \frac{1}{2} \times a \times \frac{\sqrt{3}\,a}{2}$$

$$= \frac{\sqrt{3}}{4} a^2 \text{ square units.}$$

A boy: *Oh, now I understand how the area of an equilateral triangle is* $\frac{\sqrt{3}}{4} a^2$.

Kabita: *I knew that the area of an equilateral triangle is* $\frac{\sqrt{3}}{4} a^2$ *but I also didn't know how it is derived.*

Next girl: *Sir, why did you write these "square units" after this* $\frac{\sqrt{3}}{4} a^2$*?*

Teacher: *Does anyone know why "square units" happen there?*

Students: *Yes, Sir.* [A few students' voices]

Teacher: *Sanjana, please tell.*

Sanjana: *Sir, this is the area, and the unit of area is square units.*

Teacher: *Okay, very good Sanjana. Did you listen to what Sanjana told you?*

Students: *Yes, sir. The unit of area is square units.*

Teacher: *Yes, the unit of area is square units like* cm^2, m^2, km^2, *etc.*

From the classroom observation, I saw that most of the students in the classroom actively participated in the teaching-learning process other than for a few exceptions. The teacher did not use any teaching materials and he followed the lecture method in his teaching. Discourse between teacher-students and student-student was carried out to make clear concepts. The teacher followed both motivation and intervention processes in the classroom as he practiced and experienced in the same profession for more than a decade. He used words/phrases like "*thank you*", "*very good*", and the name of the students to motivate them, students, in his classroom teaching. In some cases of lecturing, he used "*please keep quiet*", "*pay your attention*", etc. which opposed enough interactions among students. The teacher made necessary figures and mathematical illustrations on the whiteboard, forced the students to copy their exercise book, and revised many times what he taught. Although the classroom teaching was interesting to many students, a few students on the last bench did not care about learning. They were whispering by lowering their heads below the desk. I asked a few queries about their activities in the classroom when the class was over.

BB: *When sir was teaching in the class, you seemed to be joking about another subject. What was the reason for this?*

Hem: *Here, we have the provision of tuition classes in the morning and the evening too. It is compulsory for all the students appearing in the School Education Examination (SEE) and we also learn there. That is why I take it easy in the classroom.*

Sonam: *I don't know mathematics very well. Sir told me that I won't survive studying mathematics, same thing has happened. [(सरले मलाई तैले गणित पढेर खाँदैनस् भनेका थिए, त्यस्तै भयो।)[23], Saralē malā'ī tailē gaṇita paḍhēra khām̐dainas bhanēkā thi'ē, tēstai bhayō][24].*

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[23] Nepali script
[24] Romanized Nepali

When I interviewed students who did not want to learn maths, I realized that when students saw maths as a difficult subject, they paid less attention to the discussion in the classroom because they were weak in the subject matter and had the impression that they could never do well. Also, students who were very good at maths and got better results than their classmates also did not pay full attention thinking that the subject was very easy and could be done well with the help of extra coaching classes because the same thing was taught there. Thus, access to additional classes has also helped students to ignore the fact that their learning would be in the next classes. Keeping this fact in mind, Santhi (2011) argues that in some cases classes have been organized in some schools as a way to supplement emoluments for some teachers. It has also been accused that some teachers hold back their teaching duties during normal school hours because they have extra classes or time to complete their syllabus. However, some of these coaching classes focus on recalling facts instead of understanding important concepts and improving weak students. The coaching classes create a lot of stress and tension for students and teachers who have to arrive early in the morning and depart late in the evening focusing only on cognitive achievement the extra classes are unnecessary expenses (Duc & Baulch, 2012). Additional classes could have a positive impact on children if they made the learning process easier, got engaged and motivated, and maximized their learning potential. Too many extra classes can cause stress in children and thus harm their physical and mental development (Santhi, 2011). Perceptions of extra classes vary from person to person, but good quality classroom discourse during regular working hours can cope with the increase in extra classes.

Coaching classes and special tuition classes are oriented to pass the student rather than learning the skills for solving the problems. Coaching classes can damage the learning culture of mathematics by emphasizing rote memorization and repetition instead of encouraging students to think critically and independently. This can lead to students not being able to come up with their own solutions, or not having the confidence to do so. It can also lead to students not being able to apply and adapt the principles of mathematics to real-world situations.

Radical Transformation in the Education System is Necessary

When one talks about education, the question that always comes together is the quality of classroom discourse, however, the quality of classroom discourse is the abstract and broad sense that no one can clearly define. Quality of classroom discourse can be viewed in two ways, absolute and comparative but in the current context, one has to look at it comparatively (Dahal, Gupta, & Mishra, 2019). The quality of classroom discourse is understood based on differences in time, situation, geographical, cultural, economic, and social environment. Quality of discourse is understood differently. Education that helps save our culture and meet our basic needs is the quality of classroom discourse in education. Likewise, establishing basic human values is also a quality of classroom discourse in education (Dahal, Gupta, & Mishra, 2019). Quality of classroom discourse should not be viewed in the same way but from different perspectives.

The quality of classroom discourse in Karnali may not be the same as the quality of classroom discourse in Kathmandu and should be measured against the real situation of the people of the region and available resources (Kushiyait, 2011). The true quality of classroom discourse is the ability to put what has been taught into practice (learning by doing), the ability to analyze a topic and solve a given task from the perspective of excellence. In other words, the quality of pedagogical discourse in mathematics classrooms should help to develop various aspects of the students, such as knowledge, enhanced skills, norms, values , and work habits to become productive citizens. Quality of classroom discourse in education is the degree to which educational outcomes meet and exceed standards set by educational institutions, government agencies, and other stakeholders. The quality of pedagogical discourse in mathematics classrooms is characterized by high-quality teaching, learning opportunities, and resources that meet the needs of all learners and lead to improved outcomes. Quality of classroom discourse is also characterized by the development of skills, knowledge, attitudes, and values that will enable students to thrive in the world beyond the classroom (Pete, 2022). UNESCO (2018) defines the quality of discourse in education in the Sustainable Development Goals specifically as appropriate skills development, gender equality, provision of relevant school infrastructure, equipment, educational materials and resources, scholarship, or teaching force.

In the process of seeking the relationship between quality of education and classroom discourse of mathematics, I met a retired teacher and after his retirement, he used to share his long experience of teaching in different community schools all over Nepal. He had already taught for more than three decades in community schools and frequently liked to say “I am retired but not tired”. He had experience teaching students of different communities, sociocultural backgrounds, ages, and genders, so, I thought he would know more about classroom discourse, student engagement, and the multicultural context of education. I spoke with him about the quality of education, classroom discourse, student engagement, and the multicultural context of pedagogic activities.

BB: It’s a great opportunity to talk with you. Sir, you have already taught for three decades in community schools in different parts of Nepal. Regarding your experience, what are the key factors to improve the existing pedagogy in Nepalese schools?

Educator: *Teachers are the epicenter of the creation, interpretation, implementation, and transformation of classroom Pedagogy. In Nepal, schools, as well as classroom cultures, need to be reformed through rules and regulations. When the teacher spends more time on the student teaching, the student can learn more, but when the teacher cannot provide the student with enough time, the student learns less. Most schools in Nepal only use teaching methods that are no longer sufficient today. Pedagogical culture needs to be changed or replaced by new ones. Today's students expect more both from their teachers and schools. Teaching methods should take into account both theory and practice while taking into account the social and cultural foundations of related fields and cross-cultural practice. This activity forms the foundation and sustainability of the classroom teaching process. Effective learning requires demonstration, group discussion methods, role-playing, and problem-solving in mathematics. But all these skills must be well-practiced, student-centered, student-friendly, and should be practiced in a small group of students.*

Other factors also affect the quality of discourse and must be integrated into classroom discourse and these are social, cultural, and economic factors. In many parts of Nepal, teachers are not very interested in teaching children in a normal school environment because of insufficient infrastructure. Teachers follow the traditional classroom pedagogy and no longer show any interest in the modern schooling system. Although children go to school, they are busy with traditional activities at home, making it difficult for them to learn. Many parents have low purchasing power, so students do not get an opportunity to purchase more reading and writing materials. These are some of the factors that affect the quality of education in Nepal. The quality of school education depends on curriculum, education planning, school administrators, head-teachers, teachers, etc. To create a *suitable learning environment, schools must have good equipment. There must be libraries, practical laboratories, ICT integration in teaching, furniture, clean drinking water, separate toilets for boys and girls with enough water, extracurricular activities, and a healthy environment in institutions. The number of students in a class should be limited to avoid crowds and noise. Teacher management plays an equal role in improving the quality of education. A qualified teacher can teach students effectively without frightening them. Schools should not be centralized, but autonomous to operate effectively under the existing environment, socio-geographical situations, and existing infrastructure… They must be handed to the community, and a management committee must be fully responsible for the operation of the school, with well-trained teachers and financial responsibilities.*

When I had a conversation with an educator, I learned that there was a need for necessary support from various sectors for high-quality education in schools. Teachers, school principals, parents, curriculum designers, mathematics experts, book authors, educators, policy-makers, and governments - local, provincial, central, national, and international organizations involved in education must wholeheartedly contribute to the transformation and reform of today's education system in the nation. Students expected more from their teachers and schools, while teachers followed traditional classroom pedagogy that was insufficient to generate creativity in students. Other factors also influence the quality of education like social, cultural, and economic factors. In many parts of Nepal, teachers have not been very interested in teaching children in regular schools due to an unfavourable teaching environment and insufficient infrastructure. Effective learning requires demonstrations, group discussion methods, role-playing, and problem-solving, and all of these skills should be practiced well, in student-centered, student-friendly, and joyful environments within a small group of students. Although different hands and concerns were highly responsible, educators viewed teachers as the epicentre of the development, interpretation, implementation, and transformation of classroom pedagogy.

To ensure quality in mathematics teaching, teachers must be prepared, supervised, and closely monitored. On the one hand, the state administration should plan regular professional development training for teachers that introduces new pedagogies and provides opportunities to apply in the classroom teaching practices. Again, it should also hold teachers accountable when students fail to participate in a class or fail to perform academically. School regulators must be held accountable if they do not visit classrooms regularly and have insightful, observation-based conversations. The teachers in most rural schools are temporary, they are not connected to the community nor are they truly involved in the holistic development of their students due to insecurity in their job.

Chapter Summary

In this chapter, I have discussed the multiple levels of ideas generated by classroom observations and the opinions of students, mathematics teachers, principals, and educators in current situations of mathematics classroom discourse. The rich set of information from classroom observations, in-depth interviews, dyadic interviews, focus group discussions, and multi-layered data analyses have greatly contributed to the understanding of existing classroom practices in multicultural mathematics classrooms. The data analyzed through the thematic analysis method generated enough themes to discuss the multiple ideas connected to the existing literary works and the theories applied in the study.

From the observations of classroom discourses of eight mathematics teachers, and broad discussions with teachers, students, head-teachers, and mathematics educators, I extracted fourteen themes of existing classroom pedagogies in the mathematics classroom and discussed them carefully and strategically. The themes extracted were: teachers adopted interactive teaching methods; transformation of pedagogies; freedom in the classroom; learning mathematics through students' activities; mathematics: multi-dynamic and prestigious; the sternness of mathematics teachers; teaching geometry through inductive; a way for better discourse; cultural integration in mathematics teaching; visual discourse in mathematics; learning mathematics from cultural artefacts; mathematics of Nepali national flag; multicultural mathematics education; the role of the home in empowering culture in mathematics learning; and teachers alone cannot improve the overall quality of education. Above mentioned themes were discussed with rich information and they were linked with relevant theories.

CHAPTER V

ENGAGEMENT AND MOTIVATION OF STUDENTS IN THE MATHEMATICS CLASSROOM DISCOURSE

This chapter explores the engagement of students in productive activities during classroom discourse. These activities include group projects, brainstorming, problem-solving activities, games, discussions, debates, presentations, experiments, reading, writing, etc. This entire chapter seeks solutions to the second objective of the research, which was enlisted "to investigate the engagement of students and teachers on conducting classroom discourse in the culturally diverse classroom." Engagement of students includes active participation in learning, having functional skills to participate meaningfully in all aspects of one's life, being competent as a learner and problem-solver, and having a sense of meaning (Fredricks, Blumenfeld, & Paris, 2004). The teacher's attempts at all types of input go in vain without the active engagement of students in the learning process. Therefore, students' engagement plays a vital role in the sense of classroom discourse.

Student Engagement in Overall Progress

In education, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion (Fredricks, Blumenfeld, & Paris, 2004; McDonald, 2010; Parsons & Taylor, 2011) that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their schooling. Ayub et al. (2017) define student engagement as one of the learning predators as well as schools' personal development. According to the definition by Astin (1993); Kilgo, Sheets, and Pascarella (2014); and Strauss and Terenzini (2007) student engagement is active class participation, which can be characterized as engaging in class discussions, applying knowledge, and ideas, and concepts from different courses; devoting more time in completion of class assignments than non-engaged students. Engagement and motivation are critical elements in students' learning and success. Researchers (Fredricks, Blumenfeld, & Paris, 2004; Shcheglova, 2018) agreed that when students are fully engaged, they will learn better, retain more, and enjoy the learning activities more than students who are not engaged. Therefore, the more students think critically about learning especially about course materials, the more they practice, study, and learn about the courses then probably they will be able to produce better skills in everyday life (Dowson & Mclnerney, 2001; Hancock & Betts, 2002). Merriam Webster's Collegiate Dictionary (2020, June 18) defines engagement as "commitment" and Company (2004) defines engagement as "being actively committed" to be engaged is "to involve oneself or become occupied, to participate, attract or involve". Simply speaking, the concept of "student engagement" is predicated on the belief that learning improves when students are inquisitive, interested, or inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise "disengaged" (Ayub, et al., 2017; Fredricks, Blumenfeld, & Paris, 2004).

The most common conceptualization in the academic literature is engagement, which consists of three interrelated dimensions – behavioural, affective, and cognitive engagement (Finn, 1989; Fredricks, Filsecker, & Lawson, 2016; Voelkl, 1997). Stronger student engagement or improved student engagement is a common instructional objective expressed by educators in the classroom of any institution. In many contexts, student engagement may also refer to how school leaders; educators, head teachers, and teachers might engage students more carefully in the governance and decision-making processes in the school, in the design of programs and learning opportunities, or in the civic life of their society.

In the context of Nepal, from classroom observations, and personal conversations with teachers, head-teachers, and students I found that there was a lack of development of a curriculum that provides self-attraction to students in the study. Our curriculum and pedagogic activities did not attract the student's attention to the study. In this situation, the teacher's role in the classroom became the epicenter of students' learning output. Teachers had to engage the students in the classroom according to their skills – by creating a supporting and pleasant environment; using authority and autonomy power; or fearfully and forcefully. This action in the classroom had been challenging for the teachers. In a personal interview with me, a head-teacher put his views about the engagement of students on the school premises.

> *School is the place of development of students' overall progress – intellectual, physical, emotional, psychological, social, and cultural development. We are trying to manage the school infrastructure to meet students' overall needs. We know that only a few students can be good in the overall subject area but each student has a special characteristic in one special field or subject. Now, schools and teachers have a big challenge to recognize students' interesting fields of study and address them.*

From the above information, from my head-teacher participants, I came to know that a school is a place where the overall progress of students develops: intellectual, physical, emotional, psychological, social, and cultural development. Teachers tried to manage the school infrastructure to meet the overall needs of the students. Teachers also noticed that only a few students can be good in the general field, but each student has a particular characteristic in a particular field or subject. Nowadays schools and teachers face a big challenge in recognizing and addressing interesting fields of study for students.

In this line, Johnson, Crosnoe, and Elder, (2001) and Miller et al., (2011) claimed that proper student engagement increases academic effort, active participation, collaborative learning, relevance, student-friendly interactions, and intrinsic interest in students. Furthermore, Miller et al. (2011) added that it is worth noting that intrinsic motivation is a powerful indicator of when individuals will work harder, persist longer, and maintain their interest in an activity longer.

Thus, creating engaging learning experiences that are intrinsically interesting to students is a valuable means of promoting student engagement. Moreover, Kuh (2002) described that student engagement has emerged as a cornerstone of the school education lexicon over the past few decades. Classroom engagement is looked at as a catch-all term most commonly used to describe a compendium of behaviours characterizing students who are said to be more involved with their classroom activities than their less-engaged peers. Engagement refers to the time, energy, and resources that students devote to activities designed to enhance learning at schools. These activities typically range from a simple measure of time spent on studying to inside and outside of class, learning experiences that connect students to their peers in educationally purposeful, and meaningful ways (Pascarella & Terenzini, 2005). Hence, Crause (2005) argues that engagement as a multidimensional concept is both positive for some and fights against others who may not be familiar with the rules of engagement in the school setting, and teachers should prepare support for meaningful engagement and empower students to develop strategies to build on positive participatory experiences and manage the conflicts that inevitably arise from addressing the challenges of classroom learning.

Varieties of Student Engagement for Better Learning

Student engagement is an important part of classroom discourse. Without the engagement of the students in constructive work, they cannot learn what is taught in the classroom. Researchers (Leow, 2015; Long, 1996; Philp & Duchesne, 2016) divide student engagement into various folds, in which participation is reflected not only in the cognitive dimension, but also in social, behavioural, cultural, and affective dimensions so far. A semiotic work on school engagement by Fredricks, Blumenfeld, and Paris (2004) describes engagement as a "multifaceted" or "multidimensional" construct that includes, major three components: cognitive, behavioural, and emotional. It should be noted that the educators Christenson, Reschly, and Wylie (2012), McGaugh (2013), and The Glossary of Education Reform [GER] (2020, May 31) hold different views on student engagement and it might be defined or interpreted differently from place to place, time frame, and situation.

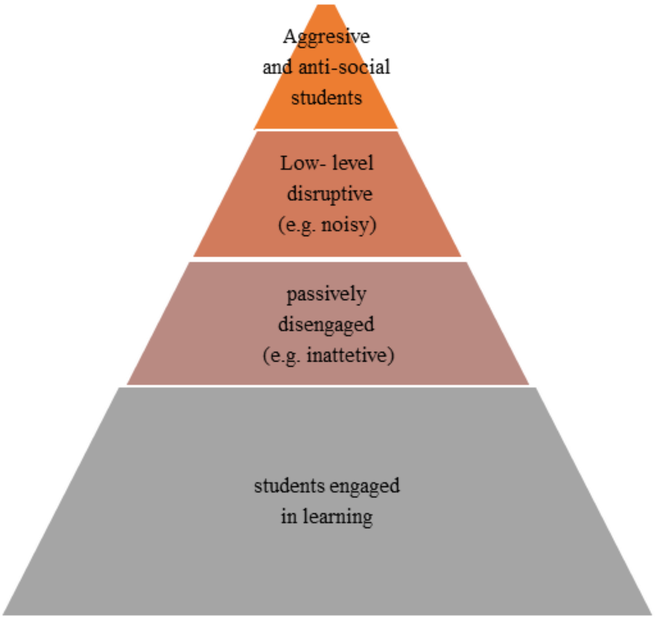

Figure 25. A Pyramid Showing Students' Behaviours

In one type of school, engagement is described as attending class, listening attentively, participating in discussions, turning in work on time, and following rules and regulations while in another school the concept of engagement may be understood as enthusiasm, curiosity, optimism, motivation, and interest (Skinner & Belmont, 1993). The various construct of engagement is described as intellectual, emotional, behavioural, physical, and social factors that play a vital role in the learning process and social development. A wide variety of research studies on learning have revealed connections between so-called “non-cognitive factors” or “non-cognitive skills”: motivation, interest, curiosity, responsibility, determination, perseverance, attitude, work habits, self-regulation, social skills, etc., and “cognitive” learning: improved academic performance, test scores, information recall, skill acquisition, memorizing mathematical formulae, problem-solving skills, etc. (Parsons & Taylor, 2011). A scientifically developed curriculum, student-friendly pedagogic activities, and interesting textbooks can attract the attention of students in the study. A mathematics teacher shared his experience,

> *It is a challenging job to motivate all the students in a classroom. Students were used to engaging forcefully in the classroom with scolding and light punishments a few decades ago. This is not in practice today. However, the engagement of students with motivation, rewards, praise, etc. is a more challenging part of the classroom than transferring knowledge through collaborative activities.*

In the context of Nepal, it is found that students are usually forcefully engaged in the classroom without their interest in the study due to a lack of motivational engagement. To overcome this problem, it is important to find ways to motivate students and encourage them to be engaged in the classroom. One of the ways to do this is to provide students with incentives for learning, such as rewards for completing assignments or achievements. In addition, teachers should make efforts to create a positive learning environment by establishing a good rapport with students and making classes interactive and interesting. Furthermore, providing students with a variety of learning opportunities and activities can help to engage them and make them more interested in the classroom. It is important to ensure that students have a safe and supportive environment in which to learn, free from any kind of discrimination or harassment.

In my observation, I found that teachers forced students to participate in classroom activities. I got only a few cases in which students participated spontaneously and intrinsically. In this scenario, a mathematics teacher expressed his experiences faced in the classroom for two and half decades.

Students have variable interests, capabilities, and aspirations. As a teacher, I have to focus on the subject matter and course of study because I have to complete the course in a limited time but students do not understand what I want. Students get happy if they are allowed to act freely in the classroom. Nowadays, I worry more than the students, about their bad performance in the exams, if the subject is not completed on time. When the grading system started, students' negligence in their studies was raised and I was shocked about it.

The above information showed that subject teachers are also concerned and worried about the students' studies. Teachers claimed that students with different interests, abilities, and aspirations in the same class and the same method of student engagement are insufficient. Mathematics teachers have a difficult job completing the lesson over time while meeting student aspirations as they foster an open classroom and enjoyable environment. Teachers worry about students' exams and grades.

The concept of student engagement typically arises when educators prioritize educational strategies and teaching techniques that have addressed developmental, intellectual, emotional, behavioural, physical, and social factors that have enhanced student learning. In this context, Curaj et al. (2015) essentially represented a basic deconstruction of student development through effective classroom involvement in three main components: behavioural development, skill development, and intellectual development. These terms have been defined respectively as the process by which a student's behaviour or performance has been changed; the process by which students' attitudes have been changed; and the process by which the knowledge, understanding, or reflective or aggregate capacity or competence of the pupil is changed is only the education of good guidance.

Intellectual Engagement

Intellectual engagement refers to students' engagement with the ideas and concepts of their discipline and the social, political, and ethical issues that are part of that context (Bowen et al., 2005; Dunne, 2013). Intellectual engagement is demonstrated through critical thinking and through students taking an interest in current debates about their discipline, wide reading, discussion with peers, and teachers, and an awareness of their own beliefs, values, and attitudes concerning the disciplines to which they are exposed (Bowen et al., 2005; Judge, Jones, & McCreery, 2009). Real in-depth knowledge is obtained from the debate. The same thing is stated in Sanskrit as vādē vādē jāyētē tattva vōdha [वादे वादे जायते तत्व वोधः]. Intellectual engagement involves the activities that are performed by teachers in the classroom discourse which connects links between students and teachers. We all know the Nepali proverb "Tarabārabhandā kalama baliyō huncha" [तरबारभन्दा कलम बलियो हुन्छ । A pen is mightier than a sword]. The meaning of the proverb is, that intellectual power is superior to any power. Students are in the phase of gaining knowledge and they learn the thing which is taught. Next Nepali proverb is also relevant here, “Vālavālikā bhanēkā kumālēkō gilō māṭō jastai hun” [वालवालिका भनेका कुमालेको गिलो माटो जस्तै हुन्। Children are like potter's clay]. This means that students can be good or bad in the future according to their guidance since childhood. Therefore, teachers feed them good knowledge that may be productive in their future. In this respect, a teacher told what he had realized in his teaching experience of 34 years.

> *We can spend 45 minutes cracking jokes or doing unnecessary gossip. But we should clearly understand that each minute of life is precious and behave accordingly. Time is irreversible, teachers should realize it and utilize it in a productive way among students that benefits students’ intellectual development. Nowadays, most teachers, including curriculums and textbooks, are focused on creative activities rather than rote memorization to enhance the intellectual skills of students. Activity-based discourse in the classroom encourages students to engage actively.*

From the above information, I came to know that teachers were aware of the proper utilization of time for students’ benefit. Teachers realized that they should use each minute to transfer useful knowledge to the students. In this respect, the GER (2020, May 31) claims that there are too many ways to increase student engagement in a course or subject, teachers may create lessons, assignments, or projects that appeal to student interests or that stimulate their curiosity. Teachers may involve students in various activities relating to any specific chapter to grow their interest in students. Teachers may give students choices over the topics that they are asked to write word equations into mathematical expressions, or they may investigate a topic or demonstrate what they have already learned, some students may solve the problems or they may explain the topics or story-making about the topics. Teachers do not think that s/he is learned and knows everything but students know nothing. Students may have their ideas about some topics which may be better than teachers' ideas. Every teacher must understand that two (many) heads are better than one head. Teachers may introduce a unit of study with a problem or question that students need to solve. The curiosity of students can be increased by intellectual engagement in the learning process. Teachers involved students in different creative activities such as debating, reasoning and problem-solving to increase their ability levels in particular areas. These activities aim to enhance the intellectual engagement of students. Other activities include group projects, music and art activities, and field trips. These activities can help students develop critical thinking skills, practice collaboration, and gain knowledge about a particular topic. Teachers may use physical activities to help students improve their motor skills and work on coordination.

Physical Engagement for Better Learning

Physical engagement refers to the engagement of students in their kinaesthetic well-being that upgrades learning movement inside or outside the classroom. By incorporating student movement into classrooms so that it is not separate from the lesson itself, teachers can strengthen the connection between certain skills and specific mathematical activities that take place within a specific learning environment (Hillman, 2014; Maddern, 2012). Educationists and researchers have remarked that the socio-kinaesthetic link positively correlated to better performance in the learning skills development and assessments of the materials (Sides & Cuevas, 2020; Shoval, 2010). Utilizing as many senses as possible helps reinforce the skills and information being used. It can also improve information recall capabilities (Basch, 2011; Maddern, 2012), in turn, mathematics, remembering or memorizing the formulae, problem-solving skills, and mathematical and logical artefacts.

If students are allowed to move in the class timely, they are always in a position of learning. Sitting in a fixed place for a day makes them lazy and fall asleep. In my interview, a teacher's comment about the students' movement in the classroom was as follows.

> *I always make students motivated as they stand up in the right place to greet me. As they are standing in their position, I make them do light physical exercises. This keeps them refreshed. I call some of them on the whiteboard to do some sort of writing of formulae, problem-solving, or making geometrical figures. But, unnecessary movements here and there during the discourse are prohibited. This sort of activity breaks the concentration in learning. Without deep concentration, mathematics cannot be learned.*

From classroom observation and conversations with teachers and students, it was noted that teachers allowed their students to make physical movements to activate the learning energy within them. Teaching certain chapters, such as height and distance, mensuration, and solid figures, teachers took their students to the mathematics lab and to the field to familiarize students with measurements of the land and the observation of the shapes of solids. Students were frequently asked questions one after another and were allowed to answer the questions standing in their right places. Some of them were brought to the board to write formulas, draw pictures, do group demonstrations, and solve mathematics problems with classmates. This type of activity allowed the students to actively participate in the discourse on mathematics in the classroom.

In this regard, Jensen (2005) argues that biologically, when student movement is acquired in the classroom discourse, the brain regulates the oxygen of entire the body that energies the mental function in the learning process. Often, students sit in the same place in the classroom on the same bench each day. Teachers may use physical activities or routines to stimulate learning or interest. Kinaesthetic learning refers to the use of physical motions and activities during the learning process. Instead of asking students to answer the question aloud, a teacher might ask students to walk up to the whiteboard and answer the question verbally while also writing the answer on the board, so-called written discourse. It is suggested that students are more likely to remember information when they are using multiple parts of the brain at the same time: the various parts dedicated to speaking, writing, physical activities, and thinking (GER, 2020 May 31). Additionally, students may even find social benefits which may lead to additional academic support. It was found that Chinese students achieved higher science and mathematics test scores than American students due to the free, managed, and disciplined movement in the classroom (Fensterwald, 2013). There has been a great deal of research that specifies that learning activities that require movement are quite effective in assisting the learning process.

When movement is maintained for more than just a moment it has the greatest impact on student achievement academically (Benes et al., 2016; Shoval, 2010). Having a classroom that focuses on kinesics, movement, and interaction can lead to an atmosphere of teamwork and trust among colleagues (Conyers & Wilson, 2015). Kinaesthetic learning can be applied as a method to help students develop effective cognitive skills. It is research-based and its purpose is extensive, encompassing psychomotor and socio-emotional concepts. Creative movement conveys to students the social and emotional attributes of self-awareness, social awareness, and self-management that install a deep connection to and understanding of self, others, and community. The movement can reach a diverse range of students and can be incorporated across the curriculum as an integral tool for learning (Guarino, 2014)

When working in a classroom that emphasizes kinesics, students are often asked to interact with other unfamiliar classmates to create cooperation and collaborative learning. Often, but not always, kinaesthetic learning requires active engagement with the surroundings of the student (Reilly, Buskist, & Gross, 2012). This may include physical objects, content materials, or tools to help them better understand the materials. To fully engage in a kinaesthetic lesson, students may need to interact with unfamiliar peers (Bauernfeind, 2016). In mathematics, students can walk on an edge to learn perimeter by putting masking tape on the ground, building a human number line to add and subtract integers, and putting their feet on different angles to feel the difference between parallel and intersecting lines.

Social Engagement for Collaborative Learning

When students are engaged socially with the intrinsic experience, it acts as a motivator helping them persist, improve their academic performance, and increase their general well-being (Caspi et al., 2006; Cristina, 2017). Students benefit both academically and personally from social engagement with peers and teachers, especially when experiencing difficulties. Social engagement has great value in their school life, family, society, and workplace. In school life, if a student is absent on any day, a socially familiar student recovers the missing classes through a good conversation with his/her classmates and subject teachers as well but the socially unfamiliar student cannot handle the same situation and feels like a big problem. Teachers emphasize the social engagement of students to be successful in their future. A mathematics teacher described his experience of blending social engagement in the learning of mathematics.

> *When I am in the classroom, my aspiration is for the students to learn. I involve my students in practical activities of measurements and problem-*

> *solving. I have made a routine to carry students to different locations. I have divided students into small groups of 6 or 7. Sometimes, they visit the mathematics lab, sometimes the audio-visual room, and sometimes the school grounds to measure the land. I have brought them to the temple areas to teach a few chapters like mensuration, circle, height, and distance. This activity blends students' verities of learning together. Along with, mathematics learning they are also learning about our cultures, society, collaboration, and cooperation. I focus on the student learning from classmates. This activity helps the students to create social bonding in and out of the classroom. I think such activities are student-friendly activities because students learn many things for fun. I think the classroom is the cage. I want to teach students without caging them.*

From the above information of my teacher participant, I came to know that friendships and peer relations can make big contributions to retention and success such as promoting academic integration, developing students' confidence as a learner, improving motivation to study, enabling students to cope with their performance, share tacit knowledge, practical and emotional support, and guidance for preparing assessments (Cristina, 2017; Thomas, 2012). Terenzini et al. (1996) found that the increased dropout of students from their teaching institution is due to a lack of social integration: less knowledge, lower test scores, less informational support from their family, less knowledge about how to navigate the academic and social experience of school life, less confidence, lower critical thinking skills, racial, ethnic, and economic status disparities. Students do not always recognize the value of social engagement and may find it difficult and/or frustrating from time to time. Efforts to increase social engagement are particularly effective in the academic sphere, as some students do not prioritize or are unable to engage in other aspects of school life (Caspi et al., 2006; Shernoff et al., 2003). The GER (2020 May 31) suggests that teachers can use a variety of strategies to stimulate engagement through social interactions. Students may be paired or grouped to work collaboratively on projects, teachers may create academic contests that students compete in such as friendly competitions in which teams of students participate in presentations, debate, mathematic quizzes, and problem-solving in a specific time interval. Academic and co-curricular activities like science fairs, child clubs, eco-clubs, capstone projects, public presentations, community service, etc. can support civic and social issues in the learning process (Skinner & Belmont, 1993). Exchange of learning experiences, demonstrating of learning, community-based learning, and learning about societal problems with self-engagement or/and participating actively in social causes can improve engagement academically, socially, physically, and mentally.

Behavioural Engagement for Active Participation in the Subject Matters

Student engagement is a broad construct that researchers have studied through three primary domains: cognitive, emotional, and behavioural engagement. Behavioural engagement refers to the student's participation and involvement in school activities, academic, social, or extracurricular (Cooper, 2014; Fredricks et al., 2016a). The behavioural engagement domain concerns questions regarding, students' conduct in class, students' participation in school-related activities, and student's interest in their academic tasks. Students conduct in the class investigates their behaviour concerning classroom or school norms, expectations, or rules (Cooper, 2014). Students' participation in school or within the classroom focuses on the students' support in attendance, positive interactions, and participation in school-sponsored activities like awareness rallies, clubs, extracurricular activities, and cultural programs which have provided insight into the students' motivation to be a part of the school (Finn, 1993; Fredricks, 2013). Behavioural engagement mostly encompasses students' interest, students' active participation in classroom activities, and students' awareness of school-related activities which help them build confidence in both academic and social activities (Pagán, 2018; Shernoff, 2013).

Teachers are the most responsible factor in the behavioural engagement of students actively, passively, or disengaged. School teachers can establish classroom routines, use consistent cues, or assign students roles that foster behaviours more conducive to learning. The class may regularly break up into small groups or move their seats into a circle for a group discussion, or the teacher may ask students on a rotating basis to lead certain activities. By introducing variation into a classroom routine, teachers can reduce the monotony and potential disengagement that may occur when students sit on the same seat, doing similar tasks for a long period. Students seek newness in sitting, grouping, and participating in the classroom discourse differently. Therefore, multiple methods of problem-solving, new techniques of memorizing formulae, and connecting the mathematical problems taught in the exercise book to everyday life can help the students' behavioural engagement positively. An old mathematics teacher told his experience with behaviour engagement.

> *Many mathematics students shake their heads as if they understand everything although they are in confusion. In my long experience, only a few students of a class are good in mathematics and actively participate in the discourse. Others are average or weak and they wish that teacher would not ask them about mathematics. This behaviour of them further degrades them. The*

teacher should understand what is going on with them and alert them to active participation

From the above information from my participant teacher, I understood that the teachers were not teaching the mathematics contexts to the students as a parrot in the cage, but they were also interested in whether the behaviour change in the students was noticed. The goal of teaching mathematics was not only the work on playing with integers but to develop social behaviours of friendship, cooperation, fraternity, cultural and social integration, and exchange through collaborative learning in different groups of classmates. In this regard, the GER (2020, May 31) claims that classroom rotation of sittings, good classroom management of performance of activities, inclusively active participation of students, and a student-friendly environment for learning are highly appreciated key factors from the teachers' side. Research on brain-based learning has also provided evidence that variation, novelty, and physical activity can stimulate and improve learning. In the same context, Camppella et al. (2013) believed that students' success depends upon child behaviours, peer relationships, and teaching practice to suggest that equitable and interconnected social structures play a role in children's engagement in classroom activities. It should be always understood that behavioural engagement in the classroom has diversified roles in culturally diverse classrooms.

Emotional Engagement for Encouraging the Learning

Emotional involvement includes positive and negative reactions to teachers, classmates, academics, and the school and is believed to bond with an institution and influence willingness to work (Cardwell, 2011). In the words of Fredricks et al. (2016), emotional engagement focuses on positive and negative reactions to peers, teachers, and schools, as well as the evaluation of learning outcomes. Also, Tuominen-Soini and Salmela-Aro (2014) found that engagement in learning activities is significantly related to academic motivation and functioning such as students evaluating their studies, getting higher marks, and reporting lower levels of academic abstinence and work evasion. Regarding the engagement of students emotionally, the most important goal connected to education improvement is the maximum development of the intellectual potential of individual, analytical skills, critical thinking, the development of self-analysis skills and awareness of one's capabilities, creative ability, an initiative with a sense of responsibility for one's actions, and interpersonal skills (Baranova et al., 2019; Barykin & Kobicheva, 2018). To achieve these goals, it is necessary to use such teaching methods and/and technologies of the educational process, which contribute to the development of students' independence, and their ability to work, taking into account the individual ways of developing educational / teaching materials, the development of communicative creativity of students, and the development of personal motivations (Cardwell, 2011; Kruglikov, 2018). Students of classes 9-10 are ages of 15-17 years in the Nepalese scenario, and they easily get emotional with small things too. It is also easy to bring them back to the right position with the small effort of teachers, elders, and guardians as well. In my interview in the field, two of the students' voices represented their emotional moments.

A girl: *I know very well; I will never forget that moment. There was a mathematics exam on that day. As soon as I got the question paper in my hand, I glanced at it all. I felt I knew nothing. Unknowingly, I cried in the examination hall in a loud voice. …. everyone was looking at me and laughing. ……., an invigilator admired me, telling me "you need to start with familiar things that you know". Luckily, I could do very well.*

Likewise, a boy participant shared his experience as,

Our maths teacher was teaching us well explaining a lot. During the discourse, he asked me a simple question that I could not answer. Everybody laughed at me saying, "You did not remember even this much". I don't know why I suddenly threw away the book. The book nearly hit the teacher. Then, I wondered what Sir would do next. But Sir easily settled the situation. I bowed my head in shame.

From the above information, I concluded that students aged 15-17 years easily get emotional with petty things too. Usually, the emotions are negative and sometimes they may be risky to themselves and others. The teachers should understand the situation and settle down the case lightly despite making it a big issue. Making the students' emotional activities wider may humiliate the students and they may drop out of their studies forever. During the classroom discourse, teachers may use a wide variety of strategies to promote positive emotions in students that will facilitate the learning process, minimizing negative behaviours that keep students from dropping out (GER, 2020 May 31).

The basic scheme is that students will be more likely to succeed if at least one adult in the school meets with a student regularly, inquiring about academic and non-academic issues, gives him/her advice, and takes an interest in him/her out of school life, personal passions, future aspirations, and distinct learning challenges and needs (Lin, 2018). Strategies of advisories, such as stronger relationships between students and teachers, students and students, and students and motivating agencies should be created. Classrooms and other learning environments may be redesigned to make students more conducive to learning. Teachers can make a point of monitoring students' moods and behaving positively. Schools can make a program to provide counseling, peer monitoring, or other services that generally seek to support students to succeed academically and feel positive, optimistic, and excited about school and learning.

Cultural Engagement for Enhancing Indigenous Knowledge

Cultural engagement of students in the classroom is the space in which we (teachers) must listen to our students and feel their feelings, which opens the opportunity for the sharing of prior knowledge and experiences, identities, aspirations, concerns, and connections (Berryman et al., 2015; Gay, 2000). Berryman, SooHoo, and Nevin (2013) and Berryman et al. (2015) accepted that nurturing mind, body, and spirit for the all-round development of students; building relationships that support student's well-being; respecting each student's physical and spiritual uniqueness; respect their value, language, and the knowledge of their identity, etc. are cultural underpins of engagement. Researchers (Ogbu, 2003; Shcheglova, 2018) have noted that if instructors and students come from different cultures, they may experience difficulties in their interactions that are caused by how they view different social positions of the teacher and student, differences in curriculum, as well as profiles of cognitive mind-sets. Cultural characteristics can also affect how students interact in the classroom and participate in teamwork as a part of project work, assignments, and presentations jointly. One of the mathematics teachers told me about his experiences of engaging students culturally.

> *Students can be more engaged in mathematics appropriately than in other subjects. Mathematics subject uses logic, concentration, inquisition, and knowledge. Students can be engaged in problem-solving in their interested topics, mathematical quizzes, mathematical puzzles, mathematical games, and so on. You know, all the games and constructions are related to mathematical measurements and geometrical patterns, eg. on the chessboard, there are square patterns. There are square and circular patterns on the carom board and good mathematical calculations on Lundo and Nagpass. There is logic in*

> *playing chess and Sudoku. Students can learn many things by playing. Nowadays, parqueting and carpeting on the floor can be seen in good rotation, reflection, and translation. Mathematics is in everything and everything is mathematics if you see things mathematically. The root of mathematics is our indigenous culture. There is nothing beyond mathematics. For details, our clocks, calendars, horoscopes, buildings, bridges, roads, temples, mosques, and monasteries all use mathematics. Even our music is based on mathematical timings. Dancing and singing are also on the exact balance of mathematical timings. The song which is sung by Kumar Basnet "Katicōṭī ghumnē kasari basnē sōraṭhī nācnālā'ī ....."*[25] *indicates the mathematical involvement in the sōraṭhī dance and this is full of cultural activity in Nepalese context.*

From the above-mentioned information, I articulated that mathematics is culturally rooted and can be easily experienced in our everyday activities. According to his claim, our music, dance, dressing, etc. are cultural and they used mathematical connections in their timings of performance. Understanding how cross-cultural interaction takes place within heterogeneous student groups is necessary both for shaping the subject curriculum and developing intercultural communication skills (Dahlin & Watkins, 2000; Shcheglova, 2018; Summers & Volet, 2008). To build strong cultural connections, schools can take active steps to make students feel welcomed, accepted, safe, and valued from diverse cultural backgrounds. Administrators, teachers, and school staff can provide special orientation sessions concerning cultural programs in multiple languages. Local cultural leaders from diverse backgrounds can present their experiences to students, and teachers can

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[25] A Nepali song that includes typical Nepali cultures.

modify lessons to incorporate the history, works of literature, arts, and perspectives of the students' ethnicities. In different ethnicity and cultures, mathematical artefacts are deeply rooted. As I was observing, one of the teachers was about to introduce the circle. At the very beginning of classroom teaching of circles and semi-circles in mathematics, the teacher made a circle on the whiteboard and asked his students ‘yō kē jastō dēkhincha?’ (What does it look like?)

Students spontaneously replied,

Yō ta hāmrī āmālē lagā'unē curā jastō cha. (It looks like a bangle of our mother.)

Yō hāmrī āmālē tihāramā pakā'unē sēlrōṭī jastō cha. (It's like the sēlarōṭī baked by our mother at the Tihāra festival.)

Haina, yō asti sūrya grahaṇa lāgdā dēkhi'ēkō riṅga jastai cha. (No, it is like a ring seen during a solar eclipse.)

Yō hāmīlē nācdā lagā'unē mālā hō. (This is the Ṭikmā that we wear when we dance.)

Yō auṭhī jastō cha. (It's like a ring.)

Hāmīlē sānōmā khēlēkō sā'ikalakō ṭyuba hō. (It is the tube of the bicycle we played with in our childhood.)

From the classroom observation with my student participants, I found that various cultural artefacts symbolized the ‘circle’, in the same way. There are uncountable cultural creations in our society from which different mathematical symbols and concepts are created. They have not explored yet. If multicultural teaching styles had been established in our classrooms connecting to everyday activities, more and more indigenous cultures might have been coined with mathematics teaching.

Students’ cultures are also reflected in their behaviours. School activities may also incorporate multicultural songs, dances, and performances that reflect the cultural diversity of the students. Students from various cultures, religions, or ethnic groups are socialized to behave differently at home than they behave at school (Ogbu, 2003). Teachers must become knowledgeable about their students' cultural backgrounds so that they can translate the knowledge into effective instruction, create a culturally responsive classroom, build relationships with the students, engage students in the learning process, and improve academic performance (Gay, 2000). Students should also be aware to protect and flourish their cultural bearings throughout the intact environments through their behaviour, performance, and positive attitude.

Engagement of Students in Strengthening the Subject Matter

There are eight subjects taught in Nepalese schools, at the secondary level. Among eight subjects, one is mathematics. As every subject has its curriculum, subject beauty, knowledge, teaching methods, and student engagement strategies, mathematics subject also has its beauty, applications, teaching methods, and student engagement strategies. A report of the national assessment of achievement in 2068, 2069, 2070, and 2072 BS showed lower achievement in mathematics than other subjects. This proved that there is something insufficient in mathematics teaching in the current situation. One of the insufficiencies may be the student engagement and motivation that creates enthusiasm, interest, and optimism in the students intrinsically. Here, I tried to throw light on the engagement of students in mathematics teaching according to different theories, researchers, and educationists which would be very fruitful to all the teachers during the classroom discourse in mathematics. There is a more chance of disengagement of students due to the student's perception and attitude toward the mathematics subject. A mathematics teacher expressed his view about the student's behaviour in the mathematics classroom while learning mathematics as,

> *Many students easily disengage with minor things too. Psychologically, students think that mathematics is a difficult subject and it is free of cultural*

connections. Students have made a habit of rote learning rather than understanding carefully since their childhood. It doesn't matter; however, they learn but they should be perfect in the subject matter. I focus on the subject matter much.

My participant teacher reported that students disengage from minor things that happen in classrooms. Students are easily distracted by unnecessary things rather than learning mathematics by understanding deeply. Many students are used to learning mathematics by memorizing rather than understanding its roots. Contemporary life requires the requirement of having good mathematical knowledge. Mathematics is important in life and supports balanced personal development (Hodaňová & Nocar, 2016). It is necessary to educate pupils on technical practice so that the knowledge of mathematics and the study of technical fields enable students to find jobs and be successful in the labour market. Regarding Attard (2012) students are said to be engaged in the mathematics classroom if they actively participate in group discussions, practical, relevant activities, and homework tasks (high behaviour); genuinely valuing is as this learning will be useful to me in my life outside the classroom (high effect); reflectively involved in a deep understanding of mathematical concepts and applications, and expertise (high cognition).

Student engagement is viewed as the quality of a student's involvement in school and student's interactions with classroom activities and materials that produce actual learning thereby shaping children's academic retention, achievement, and resilience (Skinner, Kindermann, & Furrer, 2009). In the words of Skinner and Belmont (1993) students who are engaged in classroom activities initiate action, extra extensive effort, and show positive emotions during the task assigned in addition to being enthusiastic, optimistic, and interested in the results of assignments. In the active engagement of students, the teacher's role to make sure that students understand everything that a teacher tends to teach is very important. The teacher's role in the classroom has to be changed to successfully implement the standards. The teacher must serve in the role of facilitator and allow students to persevere through the process of finding a technique for solving new problems. The teacher should have a classroom environment where students feel comfortable rather than struggling (Walker, 2015).

Attard (2012, 2014) explained classroom engagement of students in mathematics teaching in positive pedagogical relationships and pedagogical repertoires in which students and teachers collaboratively participate in teaching-learning activities. From Attard's (2012, 2014) conclusion, it is clear that teachers, students, the relevance of the mathematics curriculum, and appropriate pedagogical activities are the key factors in improving mathematics teaching. The teacher should be aware of each student's ability and learning needs. This suggests that fewer students in the classroom should be kept and teachers must be available for each student's needs. New technology should be used in a classroom and for this teachers should be technologically updated with emerging teaching tools and methods. Frequent and periodical teacher training supports the timely update of teachers, which benefits students' learning.

With the support of Chichering and Gamson's (2000) statement, "learning is not a spectator sport. Students do not learn much just by sitting in classes, listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they learning, write about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves." Similarly, Toor and Mgombelo (2017) focused on the flipped classroom approach and student-centered pedagogical approach to enable students' engagement with mathematics. The flipped classroom approach and student-centered pedagogical approach state that flipped classroom approach and student-centered approach involved the use of grade-appropriate mathematics centers where students would engage in a variety of mathematics problems and/or topics; have opportunities to practice and consolidate basic facts and operational skills; use of technology and manipulative as learning tools; become efficient communicators in math, and develop a sense of self-awareness towards their mathematics skills.

The project-based learning explores the mathematics professional learning experiences of the teachers as they implemented the flipped classroom and student-centered pedagogical approach. Teachers noted that their students became engaged with mathematics and self-regulated in their mathematics learning. Teachers should reinforce performance by creatively devising new methods of teaching mathematics. More activities need to be integrated during the teaching and learning so it would not be too teacher-centered. Mathematics activities in the classroom should involve students and they should be guided to achieve the set goals. Engaging students more in mathematics activities, and teaching them to set goals are very important as they sometimes set their own goals which are easily reached, and more often than not learning becomes static (Ayub et al., 2017). Stipek and MacIver (1989) argued about the teaching of new things and the full engagement of students. While designing mathematics activities, it should always be noted that all the components of student engagement (affective, cognitive, and behavioural) are accounted for. The enjoyable participation of students in mathematics teaching produces a positive result on the subject. The collaboration of students and teachers also produces a better learning environment in the classroom. Teachers and students honestly are responsible for their duties in and out of the classroom. The responsibility of the teacher is that s/he always be active, loving to his/her students thinking of them as their own children, ready for the preparation of lessons, put interest in student motivation, feedback/suggestions, and individual care of students as required. In-class time is utilized for inquiry, application, and assessment to better meet the needs of the individual learners.

In my classroom observation, I found that in some classroom activities, some students actively participated in enhancing their knowledge.

Activity 1

One of the teachers divided 42 students in the class into 7 groups containing 6 students in each group. He advised them to make 5 mathematics quiz questions by collaborating with the group members. All the students actively participated in making the questions. After they finished making questions, the teacher collected and mixed them. Then, the teacher started asking questions group-wise. All the students were happy and collaborated in the learning process. This activity was held for class 7 students.

Activity 2

Another teacher, teaching in class 9, asked his students to make three problem-solving questions to each student from their books individually from the already taught chapters. Then, the teacher collected the sheet of questions and distributed it to the next student to solve in 20 minutes. As students finished solving the problems, the teacher collected the worked-out sheets and distributed them to other students to check whether the problems were solved correctly or not. Students have participated fully in this activity.

Activity 3

This activity was done for class 8 students. There were 51 students in the classroom arranged on 17 benches containing 3 on each bench. The teacher was already prepared with teaching materials to teach to calculate the area of the triangle. The teacher had many pieces of paper of different sizes cut into triangular shapes. He distributed paper pieces cut into a triangular shape and asked them to measure the three edges of the paper and assign the numerical value with the letters a, b, and c respectively. Then, to find the area of the triangle, he suggested the relation as given below.

Area of a triangle (A) =$\sqrt{s\ (s-a)(s-b)(s-c)}$*, where semi-perimeter (s)* $= \frac{a+b+c}{2}$

The teacher also suggested that the edges of the triangle be measured in terms of a centimeter (cm) and the unit of area of the triangle is cm^2*. There was the full participation of students in that type of activity.*

From the multiple observations in the classroom, I argued that teachers are very skillful in the subject matter. They seem to be fully prepared with teaching materials as required and the teaching activity was already planned. Some of the teachers used mathematics labs and computer labs for practical teaching. But, in my observation, I found that the mathematics teachers were less fit technically. They hardly know about the use of specific software to teach mathematics. Only a few teachers had taken the ICT-based training to teach using recent technology. In this context, Toor and Mgombelo (2017) state that technology-assisted out-of-class time involves personal instruction, where students acquire responsibility for their learning through studying course materials on their own, using various sources.

The active engagement of students in mathematics teaching is to cultivate deeper, richer, and more active learning experiences for students where the instructor is present to coach and guide them. Moreover, the emphasis is on higher-order thinking skills and application to complex problems and collaborative learning. Students should also be responsible to participate in the learning process. They should build up a positive attitude towards the subject and the subject teacher too. Students should be silent, passionate about learning, and self-prepared in learning. Students have a vital role in creating a smooth environment in the classroom. They should understand that only the hunger for new knowledge can understand faster and better way. They should also understand that teachers do not have a ready-made capsule to be fed to transfer knowledge.

Students' Mathematical Engagement Skills

As everybody is guided by their philosophy, every student has their own view about mathematics, mathematical knowledge, feeling, identity, and habit of engagement in the mathematics classroom. Negotiating with these elements and the current context, the student's engagement in each mathematical task is different, and therefore individual students have different experiences and performance outcomes in their mathematical journey (Ingram, 2013). Students learning or/and motivation in learning is greatly influenced by social structures. For example, students from the Terai districts of Nepal are seen as more talented in technical subjects like mathematics and science than in other parts of Nepal because they see that their elders always did well in technical subjects. From their elders' connection, youngsters are also motivated or/and forced to do better in technical subjects.

Regarding Ingram (2013), there are five elements of student engagement in mathematics learning– views of mathematics, macro-feeling, identities, mathematical knowledge, and habits of engagement. Students have very different learning outcomes and experiences in mathematics despite being in the same classroom, having the same teacher, and working on the same task. This is because students have unique relationships with the subject of mathematics (Ingram, 2011). According to the views of Schoenfeld (1988), the student's knowledge is co-created by the community of the classroom and may be different from how mathematicians might conceive of mathematics. The students' conception of knowledge is related to the way the students are taught mathematics – as a series of rules, given with specific examples, and reinforced by the practice of that rule from the textbook. Although the same subject matter is taught by the same teacher with the same method at the same time, some students have special engagement skills rather than others and due to these skills, they stand superior to others in the classroom.

A teacher said,

> *If all the students had the same type of knowledge, skills, and aspirations of learning, why they would be first, second, third, and so on? Why they all are not in the first rank? This is because individual students have different skills of engagement. Some of them have good handwriting but are weak in mathematical work, some are good in mathematics but poor in social activities, some can make good geometrical figures but are weak in calculations, and some can concentrate hours on problem-solving but others do not. As you know our five fingers of the same hand are also not equal, in a similar way, we should not seek equality in students but enhance their knowledge according to their capacity.*

Teachers are aware of the individual differences of students and treat them accordingly. All the teachers agreed to enhance the knowledge of students with the help of productive activities in the classroom discourse but denied equality to them. Teachers also agreed to provide equal opportunities in the learning process but in accord with the in-built or acquired skills in mathematical knowledge, performance, attitude, and passion that make the students dissimilar from each other. In this line, Ingram (2013) explained eight types of engagement skills of students that make them inconsistent. These engagement skills are perseverance, integrity, intimacy, independence, cooperation, reflection, concentration, and utilization of feelings. Those students who develop quality of engagement elements in them can succeed in their studies. Students are supposed to grow in their ability to work independently and cooperatively as they work through various teachers' and classmates' conferencing in a small group.

Student Engagement through Motivation

One of the most difficult aspects of becoming a teacher is learning how to motivate students. Students are easily distracted by different external forces. Many mathematics lessons at the secondary level such as trigonometry, geometric theorems, and difficult problems may appeal to only a few students, but many may not be interested. In these situations, students turn their attention to unnecessary things rather than mathematical activities. A teacher shared his experience with me during the in-depth interview,

> *In my long-term teaching experiences of mathematics, I have found that many of the students bodily participated in the class but not by their souls, feelings, and interests. Some students fall asleep during classroom discussions. Students who are not motivated will not learn effectively. Neither do they (some students) retain information delivered by the teachers nor actively participate in the learning activities.*

The teacher wanted to explain that pupils without motivation and interest in the lessons easily disengage from the class. Due to less interest in mathematics and lack of motivation, the teacher had many problems such as falling asleep, and physically in the class but mentally out. Teaching mathematics may not be useful to both students and teachers in such situations. To lead students back to related lessons, teachers must take on many roles like a motivator, actors, parents, prophets, guides, and many more. Therefore, teaching mathematics was not an easy and satisfying job according to some teachers**.** Durksen et al. (2017) claim that much of the effect of teachers and classrooms on student learning relies on interactions. Teacher-student relationships have positive and significant associations with academic measures including motivation, engagement, and performance (Hamre & Pianta, 2005; Martin et al., 2009; Pianta, Steinberg, & Rollins, 1995; Pianta & Walsh, 1996). Teachers may operate as social agents, and they can affect students' intellectual and socio-emotional experiences by creating a classroom setting that stimulates both student motivation and learning. Positive teacher-student relationships can lead to a warm classroom environment that facilitates successful adaption in school and thereby increases student motivation to learn (Koca, 2016). Students' perceptions of the teachers are the key factor for the student's learning output. The classroom setting, classroom environment, pedagogic activities of a teacher, and student-friendly classroom discourse are some indicators, stepping on which, students relay their perceptions. A female student shared her view on classroom experience in mathematics learning in the following way.

> *Our mathematics teacher frequently motivates us to connect the importance of mathematics in the future. This increases our interest in learning. He tries to make us understand as much as possible with many examples. He makes*

> *necessary figures, discusses among us, and allows us to solve problems on the whiteboard.*

Students had their way of evaluating teachers. Most students preferred teachers who often motivated students on related topics and subjects by relating their usefulness to the future. The motivation sparked interest and focus in teaching. The motivation of the student helped in creating self-awareness and enthusiasm for learning. Effective motivation is a state of cognitive and emotional arousal that leads to a conscious decision to act and that causes the exertion of intellectual and physical effort toward reaching a previously set goal (Reeve & Lee, 2014; Williams & Burden, 2000). Mathematics teaching is followed by two types of discourses (e.g., cognitive discourse and motivational discourse) (Solomon, 2019). Motivational discourse refers not only to praise offered to students but also to supportive and non-supportive statements teachers make that encourage or discourage participation in mathematics classroom discussions. Teachers' view toward the students plays a vital role in mathematics teaching and learning. In my interview, a mathematics teacher expressed his experiences about classroom teaching.

> *I have found my students very sensitive in mathematics teaching. Perhaps, having a feeling that mathematics is a difficult subject, students are ready to learn quietly as soon as I enter the classroom. They are already prepared with the necessary learning materials with them. I also entered the class with full preparation for teaching lessons.*

Depending on the behaviour and teaching styles of teachers, they were faced with unique types of experiences. The teacher found his students positive, supportive, and participatory, believing that mathematics is a difficult subject and that we must be ready to learn calmly. But some teachers have experienced student disengagement, less interest, and unfavourable thinking that mathematics is a difficult subject. Although students have similar thinking like “math is a difficult subject,” different groups of students engaged and behaved differently due to the motivating and demotivating roles of teachers in the classroom. Supportive motivational discourse occurs when teachers focus on learning through mistakes, collaboration, persistence, and positive affect (Solomon, 2019). Motivation to students is the action of teachers – praising, telling experiences, story-telling of successful personalities, etc. that students can feel as if the “teacher is doing it for me and I should do it at any cost” (Filding-Wells & Makar, 2008). As shown in the figure, from the motivation one teacher transforms his/her students from “I can’t do it” to “I can do it”.

Figure 26. Effect of Motivation (Adopted from Google)

Student Encouragement for Encouraging the Learning

Praising the students is one of the most effective and easiest ways to lift their spirits and keep them working hard. Excitement is contagious and shows students that the teacher is happy to be with them and guides them on their mathematics journey will make a difference in how they view the class that a teacher is teaching (Vrener, 2020 June 16). Being energetic, creative, having fun, and inputting positive feelings can create excitement for the students. As we (teachers) know the best teachers do more than they teach, and this "more" is certainly the "encouragement". No one can become fluent after doing the same task repeatedly but they are bored, and it is obvious that some students get easily discouraged if they fail to solve a simple problem too. In such a situation, the best thing for students is to create the feelings of "I can do" by motivating, praising their little success, and setting them challenging but still reachable goals. If students can reach the pre-set goals, they celebrate their achievements and the teacher should not stop them. In my observation, I found encouraging tasks of teachers. A head-teacher in the joint meeting of members of the management committee, teachers, and non-teaching staff said,

> "Young children learn from everything they do. They are naturally curious; they want to explore and discover. During these early years, children develop attitudes about learning that will influence their school life. When we provide the right sort of support and encouragement during these years, the student will be more creative, adventurous learners throughout their lives than children who do not receive this support". Koca (2016)

> *None of us should underestimate the students' activities. We should not demoralize the students at any cost. All the unexpected activities that go on the school premises are due to the discouragement, discrimination, devaluation, and demoralization of students. We all need to avoid these 4-Ds from our behaviours.*

It was clear that the head-teacher wanted to inform all members of the management committee, teachers, and non-teaching staff that they should follow good governance in the classroom as well as on school premises. All students should be motivated, encouraged, and behave positively rather than discouraged, discriminated against, devaluated, and demoralized. Not only linguistically but practically, the teachers in school followed the 4D rule in their behaviour in school “A” as much as possible, but it was not applicable in other schools. However, I didn't notice the unexpected activities made for the students by the teachers in my observations. None of the students claimed the violent activities by the teachers. Therefore, I did not experience the case of hard and fast punishment rules in the schools. One of the students in class 8, told his experience of how he was motivated, and the teacher encouraged him.

> *At the beginning of the class, I disliked math. When the teacher gave me the classwork, I would pay attention to other things than my study. When the teacher asked why I didn't do it, I used to say, I missed a pen, exercise book, or something like that. But the teacher used to give me his pen to do the problems and noticed me carefully whether I was doing it or not. If I could not do it, he taught me with better care. This habit of mathematics teacher encouraged me to do mathematics work. As a result, I am good at mathematics now.*

Here, the student's behaviour was against learning mathematics and he used different strategies not to learn mathematics as he said, forgot a pen, notebook, book, and something like that because he didn't like math. The teacher also encouraged him to provide a pen if he did not have one and to take care of him. This type of motivating action became fruitful for learning and eventually, the student became interested in learning mathematics. A small encouragement to students during their study time can change their entire life of the students (Hewson, 2018), especially small financial support for financially weak students, moral support for those depressed, and educational support for needy ones. Miller et al. (2011) state that a teaching institution can launch a variety of programs that can be used to promote students' engagement including organizations, internships, learning communities, and project-based learning which encourage and support student engagement in both academic and social realms, and therefore have a positive impact on the overall schooling experience.

Engagement of Students Through Equity Pedagogy

Children of certain racial, ethnic, language, gender, ability, and socioeconomic backgrounds experience mathematics education in school differently, and many are disaffected by their mathematics education experience (Aguirre et al., 2017; Aguirre, Mayfield-Ingram, & Martin, 2013; Butler-Wall et al., 2016; Chao, Murry, & Gutiérrez, 2014; Milner, 2013). A mathematics education that does not result in the negative experiences, fears, anxieties, and disaffected mathematical identities that we continue to encounter in schools and society can help to maintain equity in education. Equity in education is a measure of achievement, fairness, and opportunity. According to the Merriam-Webster's Collegiate Dictionary (2020, June 18), the definition of equity is "justice according to natural

> "Creating, supporting, and sustaining a culture of access and equity require being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and accessing its effectiveness. Acknowledging and addressing factors that contribute to differential outcomes among a group of students are critical to ensure that all students routinely have opportunities to experience high-quality mathematics instruction, learn challenging mathematics content and receive the support which is necessary to be successful. Addressing equity and access includes both ensuring that all students attain mathematics proficiency and increasing the numbers of students from all racial, ethnic, linguistic, gender, and socioeconomic groups who attain the highest levels of mathematics achievement." NCTM (2014)

law or right; freedom from bias or favoritism". The Organization for Economic Co-operation Development (OECD) (2008) defines two dimensions of equity in education – fairness, which means ensuring that personal and social circumstances do not prevent students from achieving their academic potential, and inclusion, which means setting a basic minimum standard for education that is shared by all students regardless of background, personal characteristics, or location (Thinking Maps, 2020, June 18). Various researchers viewed equity in mathematics education through different lenses and dimensions. Chao, Murry, and Gutiérrez (2014) in Gutiérrez (2009, 2011) suggested four dimensions of learning to address equity in mathematics teaching – access, achievement, identity, and power. According to these four dimensions, equity-based mathematics teaching means practices that consider the way(s) mathematics education perpetuates oppressive norms and therefore actively seek to erase them so that all students can participate meaningfully in mathematics learning and create their mathematical knowledge (Chao, Murry, & Gutiérrez, 2014).

Creating equity in the classroom while teaching mathematics is one of the challenging jobs because our classrooms are diversified. Students come from different societies with different languages, races, ethnicities, religions, socioeconomic backgrounds, and cognition. Equity-based mathematics teaching requires more than implementing a new curriculum or using specific practices – it involves taking a stand for what is right. It requires mathematics teachers to reflect on their own identities, positions, and beliefs regarding racist and sorting-based mechanisms (Chao, Murry, & Gutiérrez, 2014; NCTM, 2014). Caswell (2011) raised the main four themes to provide equity in the mathematics classroom – examining the achievement gap, providing access to a high level of mathematics, exploring issues of social justice through mathematics, and culturally relevant pedagogy and student identity.

In my classroom observation, I hardly found equity in teaching-learning activities. In some classrooms, the arrangement of desks and benches were the barrier to reaching students directly. I saw teachers checking home assignments and class assignments only partially. One of the student’s reactions toward equity in teaching-learning activities stroked me.

> *Teachers do not behave equally. Mathematics teacher checks the homework of only talented students rather than weak ones like me. Only the talented student gets a chance to the presentation, display their work, and participate in the mathematical quiz. If talented students say that the chapter is finished, the teacher starts the next chapter ignoring weak students. This is not a principle of equity pedagogy. To create equity, a teacher should better care for weaker students like me rather than the talented ones.*

The student reacted in the same way, as I also noticed in the observation of the classroom engagement of students in mathematics. Some of the mathematics teachers rarely checked homework and classwork individually and completely. This was because there were a large number of students in the class and if the teachers checked the homework individually, they would not have time to teach the lessons and finish them on time. One of the mathematics teacher's experiences was also notable along the same lines,

> *I have to manage more than 50 students in the classroom within 40 - 45 minutes and if check the homework individually, I will not have time to finish the lessons. So, it's true that I alternatively check homework and at least one student at a desk. The other students can make corrections by watching their classmates. But if I had enough time, I would personally check the homework and give adequate feedback.*

The teachers' experiences and statements also supported my classroom observation and document analysis. When I saw the students' exercise book, I found that there was proof of students' homework checked periodically by mathematics teachers, and the rest was corrected by the students themselves with the cooperation of their classmates. In the context of Nepal, teaching in a multicultural classroom has become more challenging. The same type of classroom discourse is not sufficient to satisfy all the students as students have different cognitive levels. Therefore, choices in the discourse, choices in classwork, and home assignments have become necessary. The verbal problem in mathematics should employ multicultural essence (e.g., for the problem of trigonometry in teaching "*height and distance*" a problem like – a temple with a height of…., is religiously or culturally dominated. In terms of "temple" why is not there a "mosque", 'church', 'stupa' etc? Similarly, in social studies teaching, how do you celebrate the *Dashain*[26] Festival? In terms of '*Dashain*', there should be enough choices like '*Buddha Purnima'*, 'Eid', 'Ester', '*Chhath*', '*Unvauli*', '*Undhouli*', '*Lhosar*'[27] etc.). On one hand, the cultural identity of the student is growing and on the other hand, the teachers are mostly carrying a mono-cultural perspective. One of the Tamang girls expressed her dissatisfaction with the trend of teaching-learning activities in the classroom.

> *I am from the Sindhupalchok district. I studied in my hometown up to sixth grade. I came up here in this school and was admitted in grade seven. I studied mathematics in the Nepali language there but here is the English language, which I cannot understand. I cannot even understand the Nepali language very easily. In our village, we were taught in the Nepali language but frequently my friends who understand complete Nepali used to translate it into our native*

[26] The biggest festival in Nepal. This festival is celebrated by Hinduism.
[27] Italicized words represent the different festivals celebrated in Nepal.

> *Tamang language which made me easy to understand. But, here (in Kathmandu) none of us do the things similarly that we did in our village. I came here aiming to have better education but I think I will leave this school very soon and go back to my home.*

From the above expression, it was easy to understand that our classrooms are, of course, multicultural and multilingual but we have mono-cultural and monolingual pedagogy. Marginalized groups of students are more victimized in our mono-cultural classrooms. It is now time to employ multicultural, multilingual, and multimethod teaching to address all students' essence. Multicultural education needs a community-centered approach. Each community has its empirical knowledge, which is transmitted to new generations through tales, stories, songs, proverbs, etc. (Dhakal, 2014). The participation of students; and families in school activities is an important element in students' achievement, encouragement, and equity. Teaching materials in the classrooms are mono-cultural, presenting only a 'dominated ethnic and cultural model' (Setati & Barwell, 2008). Multicultural teacher training and a multicultural curriculum are necessary to teach in multicultural classrooms.

The Dilemma in Students' Engagement

Teachers' perceptions of students play an important role in their overall progress. Teachers mainly make a specific perception of individual students – productive, unproductive, noisy, disturbing, etc. Dichotomized teachers' beliefs about productive and unproductive students are at the center. Most of the teachers are very positive towards productive students rather than unproductive ones. Productive students follow their timetables strictly in school as well as at home. They come to school every day, listen to their lessons, and actively participate in the classroom discourse. They regularly complete their home assignments on time, repeat their lessons frequently, and produce good grades in the examinations too. Teachers have no more challenges on productive students because they are conscious of their studies and a little hint is sufficient for them to achieve. In my interview, one of the head-teachers put his reaction in a very systematic way.

> *A student kicks the door with his foot and breaks the window glass with his fist unless we can use the potential energy developed in him/her in the right place. If the same energy could be put to good use in football or boxing, s/he would be applauded instead of scolded. Today's need is to turn abuse into applause. Teachers should act accordingly.*

The principal wished to share his experience with the habits of the pupils which could be perceived as oriented in a positive direction. Students are energetic, and if not guided adequately in the constructive roles of reading, writing, extracurricular activities, and games, they can abuse their potential and become the characters of hate. School principals expected teachers to manage student behaviour through their creative, participatory, and constructive roles in the classroom. Usually, teachers are more worried about unproductive students because they are frequently distracted from their learning in the classroom.

In this line, a mathematics teacher shared his view,

> *In the context of Nepal, most of our classrooms are multicultural, there are varieties of students in the classroom. They are equal in only the word 'students' but their level is different. They have a difference in learning capacity and learning styles, cultures, socioeconomic status, languages, religions, and physical aspects too. Our teaching methods and school environment fit some of them but are unfit for others. Those students who feel a positive environment are good at learning but those who feel negative are*

> *not. Those students who are not good enough at learning, disturb the classroom. My eyes are always on their (disturbing students') activities and make them aware of learning.*

The mathematics subject teacher claimed that the students who were good at learning i.e., productive students were helpful and cooperative in the classroom discourse and actively participated in the classroom activities. However unproductive students were disruptive in the classroom discourse. They hardly participated in classroom activities and rarely collaborated with classmates in learning. They did not listen carefully in class, did not complete the homework on time, disturbed other students, and gossiped unnecessarily in the classroom.

In the view of Chinn (2010), some students can engage in behaviour that is undesirable or inappropriate in the eye of teachers and peers too. Some of these ‘inappropriate’ behaviours are characteristic of developmental stages and are therefore ‘appropriate’ if viewed developmentally. If a student is developmentally delayed then the behaviour may be understandable and appropriate from a developmental perspective even if it is not acceptable from a chronological perspective. The most common misbehaviours included idleness, lack of work avidness, hindering others, and talking out of turn. Serious behaviours such as physical destructiveness and aggression are relatively uncommon (Sullivan et al., 2014). Sullivan et al. (2014) and Drogemuller (2018) categorized the unproductive behaviours of students into three parts disengaged behaviours, low-level disruptive behaviours, and aggressive and anti-social behaviours.

Disengaged behaviour is – being late for class, avoiding doing school work, disengaging from classroom activities, and being absent from class frequently. Low-level disruptive behaviours are – disrupting the flow of the lesson, talking out of turn, making distracting noises intentionally, interfering with property, moving around the room unnecessarily, using a mobile phone inappropriately, bringing unnecessary things into the classrooms, making impertinent remarks, mucking around, being rowdy (Moallem, 2019). And aggressive and antisocial behaviour is – spreading rumors, excluding peers, verbally abusing other students, abusing teachers, sexually harassing other students, being physically aggressive towards other students, physically aggressive towards teachers, being extremely violent to students or teachers, and displaying uncharacteristically erratic behaviours (Nuraini, Solihin, & Rachmadtullah, 2018). Teachers indicated all categories of unproductive behaviours that exist in classrooms, but teachers most frequently encountered disengaged behaviours and low-level disruptive behaviours. In a similar context, Langone (2002) states that many children display inappropriate or problematic behaviours in the classroom which can make it difficult for them to learn, cause harm to their child and isolate the child from his/her peers. We often speak of problem behaviours in terms of the effects they have on others. We should categorize unproductive behaviours and search for the necessary care for them.

Misconceptions of Student Engagement in Mathematics

The engagement of students is viewed differently according to the perceptions of the teachers. To be engaged in the classroom is not only to listen carefully to what the teacher delivers, but students should get enough opportunities to interact with the teacher and colleagues of the class over the issues of mathematics. Attitude is defined as a mental set or deposition, readiness to respond, and the psychological basis of thinking, performance, learned nature, and evaluative character which is favorable or unfavorable to an individual (Davadas & Lay, 2018; Moenikia & Zahed-Babelan, 2010). It is possible to define the concept of 'attitude' which is at the very heart of the defining point of an individual's behaviours. Attitude is the cognitive, sensory, and behavioural positive or negative inclinations of an individual and is directed toward the events, people, objects, thought systems, and institutions within the limits of one's perceptional realm (Yasar, 2016). A positive attitude towards mathematics reflects a positive emotional disposition concerning the subject. Similarly, a negative attitude toward mathematics relates to a negative emotional disposition (Eshun, 2004). These emotional dispositions have an impact on an individual's behaviour as one is likely to achieve better in a subject that one enjoys, has confidence in, or finds useful.

In my observation of grade IX, while the teacher was teaching the "profit and loss" chapter, I saw three students on the second-last bench flirting with each other without paying attention to the learning activities. In the classroom, I sat quietly as I did not see their activities. After the class was over, I called them to a separate room and tried to find the reason for not paying attention in the classroom.

A boy (Dharmendra):

> *I know that I am very poor in mathematics. I studied in a rural village till class 8 and was admitted to this school in class 9. I tried a lot to understand the subject but it was not possible. The mathematics teacher also did not care for me individually. Some of my classmates also focus on making noise in the classroom rather than learning while the teacher teaches. As a result, I don't like studying mathematics now.*

The next boy (Anjel):

> *Um…., what to say? It is very difficult for me to learn mathematics. I think only talented students can learn it. I do have not enough capability to learn mathematics. I hate this subject. Why is it that, I don't know when I look at a mathematics book, I feel a painful headache?*

The next boy (Vivek):

> *My brother was very good at mathematics. Even though he passed his Bachelor's level with an excellent grade, now works in a departmental store. He tried to teach me a lot but I couldn't. I could not learn even in school. Then my brother started asking what happens if I study, after all, I have to work to eat. Good education alone does not provide food. After that, my study deteriorated and became more and more fragile. I don't like to look at mathematics anymore.*

In my observations and personal conversations, I found that some students thought negatively about learning mathematics. Mathematically, weak students' feeling toward mathematics subject was heart-touching. For this reason, a positive attitude towards mathematics is desirable since it may influence one's willingness to learn and also the benefits one can derive from mathematics instruction (Eshun, 2004; Mata, Monteiro, & Peixoto, 2012). A proverb in Nepali society "banakō bāghalē khā'ōsa nakhā'ōsa manakō bāghalē khāncha" [बनको बाघले खाओस नखाओस मनको बाघले खान्छ।[28] whether the tiger of the forest eats or not, the tiger of the mind eats] is rooted very deeply. The meaning of this proverb in mathematics learning is as – although mathematics is easy, psychologically, almost all the students think that it is a difficult subject and this really makes it difficult. Some students have difficulties in mathematics classes and this creates increased anxiety levels because they think that they cannot succeed in mathematics, and therefore develop negative attitudes toward mathematics classes (Yasar, 2016). In the study of the attitude of students towards mathematics, many instruments have been developed based on various definitions of attitude – attitude towards success in mathematics, confidence in mathematics, the

[28] Nepali script.

usefulness of mathematics, perception of the teacher, mathematics anxiety, as well as gender roles (Larsen, 2013; Panthi, 2012; Wilson, 2011). A mathematics teacher told me about four constructs of attitudinal behaviours of students, he had experienced in the classroom teaching of mathematics.

> *In my mathematics teaching experience, I have noticed a variety of student attitudes and behaviours toward math. Among them, some students get nervous while working on mathematics problems. Some students experience a feeling of sadness. Some find learning mathematics very frustrating. Some are reluctant to ask mathematics questions in class. Some students get nervous when I'm in class. However, some students are very interested and confident in taking mathematics tests and love math. Some students say that no other subject is as fun and useful as mathematics and that they also do mathematics activities during periods of other subjects. Some students love mathematics games, puzzles, and quizzes. I often see students playing with ruby cubes, solving Sudoku puzzles, and building mathematics formulas, rules, and tips to remember facts from other subjects as well.*

From the teacher's statement, it was clear that students' mathematics learning was reflected in the attitudinal behaviour they exhibited in the class during classroom activities. The teacher highlighted the four behavioural constructs in the conversation. Getting nervous when working on mathematics problems; experiencing a feeling of sadness; finding mathematics very frustrating; reluctant to ask mathematics questions in class; reflected mathematics anxiety. Students' interest and their confidence were reflected in the saying – interesting and confident to take mathematics tests and love math; no other subject is as fun and useful as math; do mathematics activities in periods of other subjects; love mathematics games, puzzles, and quizzes. The usefulness and application of mathematics in their daily lives as well as in other subjects were reflected in the words, I see students playing ruby cubes; solving Sudoku puzzles; and creating mathematics formulas, rules, and tips to remember facts from other subjects as well. There are too many attitudinal behaviours of students that can be seen in the classroom discourse of mathematics, which directly or indirectly (un)supports the students' learning outcomes and these attitudinal behaviours are confidence in mathematics; the usefulness of mathematics in daily life, and future; mathematics anxiety; and students' interest in mathematics learning (Kasimu & Imaro, 2017). The students' perceptions of mathematics can play a seminal role in the learning of mathematics, learning outcomes, and overall development in the future.

Many hidden factors are not seen on the surface but more or less affect mathematical achievement and attitude toward mathematics learners. It has been observed that there is no meaningful difference in terms of mathematical attitudes of high school students when the concerning factors are considered. These factors are attending a course, receiving private mathematics lessons, genders of mathematics teachers, perceived success levels of students, educational status of the mothers of the students, number of siblings, the order of the student within the family, and the genders of the high school students (Yasar, 2016). In the context of Nepal, teachers are also responsible for the development of attitudes toward mathematics students. From the childhood of students, their teacher tells them – 'mathematics is a difficult subject', 'you cannot do mathematics', and 'your achievement in mathematics is poor' etc. This type of teacher's behaviour helps to increase the mathematical anxiety of students and their feelings about mathematics go on being worse.

Engaging Un/Productive Students

Productive and unproductive students are the teachers' perceptions according to the behaviours represented by the students in the classroom discourse. Classroom management is intended to provide students with more opportunities to learn all of the things that a teacher does to organize students, space, time, and materials so that students' learning can take place smoothly. Students should be able to carry out their maximum potential, which allows students to develop appropriate behaviour patterns. Teachers must deal with unexpected events and have the ability to control student behaviour, using effective classroom management strategies. Effective classroom management and positive classroom climate construction are essential goals for all teachers (Sieberer-Nagler, 2016). Praising and motivating students is very effective when it is sincere and natural. Respect for the students is also an important factor in engaging the student positively and improving their bad habits or behaviour of students. To react positively to wrong answers is a way to teach positively. A good relationship between students and their parents is also necessary to draw the ill-habitual students in the correct direction. Students like it when a teacher uses their names while responding to them. Cooperation between students is necessary while designing the class routings, sittings, lesson planning, class tests, and practical activities. It should always be noted that a small thing makes a big difference. Teachers need to change their dominating characteristics, self-centered teaching, and aggressive nature into collaborative learning, student-centered teaching, and student-friendly teaching. A head-teachers view of the students in the classroom was,

> *All students want to create a lifestyle with passion and creativity. They are trying to find the meaning of life, are trying to do something more than others, and are trying to be unique. Each student tries to be good to himself/herself.*

> *Sometimes even doing well can be harmful in the eyes of the teacher and classmates. Every student has hidden potential. The teacher should recognize this hidden potential and teach, and manage accordingly. All students are qualified and courteous according to the environment in which they grew up, the structure of society, and the socio-cultural context. Support of teachers should not be about getting more grades in a specific subject such as mathematics but should focus on overall development.*

The head-teacher wanted to convince me that the students were not unproductive and unsuitable in class. They are capable in different ways and may have unique hidden potential within them and teachers need to find and support it to expand it rather than thinking about getting more grades in a certain subject. All students could be qualified and courteous depending on the environment in which they grew up, the structure of society, and the socio-cultural context. Each student has tried to be good in himself/herself, but sometimes even doing well could be harmful in the eyes of the teacher and classmates. In a similar context, St. William School's (2020, June 22) vision of productive education in diverse classrooms is noteworthy. Each student is passionately and creatively created for lifestyles and seeks to identify himself/herself. They are long-time students, with a preference for seeking reality and doing what is right; responsible for choices and responsible for actions. Each learner can gain satisfaction in lifestyles and gain knowledge, where the range is assessed and shared awareness contributes to the decision-making process that enriches and revives our world. Each student leads to the acquisition of the knowledge of joy in his adventure of richly different lifestyles to make his contribution to a network in communion, empowered by a means of cultural accompaniment.

Good teachers care deeply about students and can build positive relationships with each other. To be effective, good teachers go out of their way to understand the culture, climate, and more of the community that makes up the schooling. The teacher should know the student personally by their cognitive level, abilities, interests, cultures, and behaviours. According to the cognitive level, behaviours, interests, cultures, and abilities, if students responded separately, there is no misbehaviour at all in the classroom discourse and the classroom teaching becomes fully democratic (Dodge, 1943; Jeffryes, 2013; Sieberer-Nagler, 2016). Dealing with students in culturally and socially diversified students is one of the most challenging jobs rather than teaching in the classroom at the high school level. One of the ways of managing, especially unproductive behavioural students is to use soft language while giving feedback rather than scolding them among classmates.

It is also important to talk directly to the student about their unproductive behavioural issues. This shows respect and helps the student to take responsibility for behaviour, whether it is inappropriate behaviour or positive progress. Talking first to parents or another staff sends a signal to the student that teacher does not respect his/her privacy and that you (teacher) do not think that s/he is capable of taking responsibility or credit for behaviour independently (Jones & Jones, 1986). Being courteous is also very important to improve the behavioural activities of students. This includes giving students full attention when teachers are talking or listening to students as well as saying ‘please’, ‘thank you’, and ‘excuse me’.

Using ‘I’ statements is also very useful in communicating effectively with students. ‘I’ statements convey how the consequences of a student’s behaviour make you (teacher) feel. For example, during the teaching of geometry, Mahesh turns around in his seat talking to his classmates behind him. The teacher stops talking, looks at Mahesh, and says loudly, "*Mahesh, can't you ever be quiet? You are constantly interrupting me and I'm not going to take this class anymore!" I say, "keep quiet.", "no more shouting.", "shout up.", "stop shouting.*" and so on. In these reactions, Mahesh (is) likely feels angry, humiliated, and defensive. The teacher could instead calmly say, "*It is frustrating to me when students whisper while I am trying to teach. It distracts me and makes me feel disrespected. I would appreciate it if private conversations could wait until later.*" If Mahesh did not respond to this cue, the teacher could take him aside and say, "*Mahesh, it makes me feel frustrated when you whisper during my discourse. I lose my concentration and my teaching is less effective.*" Such types of positive behaviour from teachers draw Mahesh's attention to his behaviour and challenge him to take responsibility for it. Here, the teacher is not attacking him (Mahesh) and is avoiding embarrassment by taking him aside.

Feedback also helps cultivate a positive rapport between teachers and students. Specific, non-judgmental comments about student behaviour, both appropriate and inappropriate, communicate to students that they are responsible for and in control of their behaviour (Jones & Jones, 1986). The teacher should be democratic, unbiased, and avoid students' comparisons. Feedback must be contingent upon behaviour, which means it is dependent upon and immediately following it. It is also important to give praise to students for their good work. Students are often told that they are good at something rather than that their hard work and determination have resulted in success. Students must attribute success and failure to factors under their control.

Giving example, a mathematics teacher added "*Sneha, this is an excellent work. It shows that you worked very hard on this assignment and your mathematical skills are seen in it. You should be very pleased with what you can do. I am very pleased with your work.*" Giving students cues, prompting, and giving time to think of an answer are all signals to the students that the teacher has positive expectations for them (students). Encouraging students by asking those questions you (teacher) know they can answer. These teacher behaviours communicate to students that every one of them is valuable and can succeed. Thus, positive communication with the students is beneficial for both students and teachers in the teaching-learning activities in the classroom.

Chapter Summary

In this chapter, I explored the engagement and motivation of students in the classroom discourse of mathematics. As the individual differences occurred in each of the students, they engaged differently during the classroom discourse. Various types of engagement exist practically, e.g., intellectual, physical, social, behavioural, emotional, and cultural engagement. Teachers were skillful in the engagement, motivation, and encouragement of students thinking that these factors were directly proportional to the student's learning output.

Mathematics teachers were worried about the inactive participation and easy disengagement of students in the classroom. Teachers categorized the students into two parts 'productive' and 'unproductive' in accord with their perceptions. Most of the productive students were happy with their mathematics teachers' classroom activities and found to be positive in the classroom discourse whereas unproductive students were unhappy with the teachers and pedagogies of the classroom. Students felt mathematics was a difficult subject psychologically, and mathematical anxiety demoralized the study. Due to the existence of diverse cultural, socio-economical, and cognitive variations in the classroom and the lack of multicultural and multilingual pedagogic activities, marginalized students faced problems in learning mathematics. Only a few students in the classroom were good enough in mathematics subjects and the rest of the class were averagely or weakly categorized, and they sometimes showed unexpected emotional activities towards their classmates and teachers as well. Teachers managed the so-called ‘unexpected’ activities in their eyes, wisely and tactfully rather than violently. Demoralization, discouragement, discrimination, and evaluation of students were minimized to ensure positivity and productivity on them.

CHAPTER VI

PROMOTING STUDENT-FRIENDLY CLASSROOM DISCOURSE IN THE MATHEMATICS

"Every student's identity, language, and culture need to be respected and valued.
Every student has the right to access effective mathematics education.
Every student can become a successful learner of mathematics."

- Klerlein and Hervey (2020)

Talking is "an effective way for children to clarify their thinking, discuss new possibilities, extend the thinking of others, and rehearse their ideas. In these ways, children can become proficient and articulate in communicating mathematical ideas"

- (Whitin and Whitin, 2002, p. 210).

Mathematics educators, teachers, educationists, and governments are always seeking alternative ways and making strategies to promote the existing pedagogies as well as education systems by making suitable education policies and practices. Pedagogical discourse in the mathematics classroom is one of the ways to improve the atmosphere of mathematics teaching because if the students understand the basic mathematical ideas from the collaboration with teachers and colleagues or they make the habit of understanding everything that is taught in the classroom with enough queries and active participation, then they would construct their intrinsic ideas in the subject matter. Mathematical discourse plays a vital role in making conjectures, talking, questioning, and agreeing or disagreeing about problems to discover important mathematical concepts (Lampert, 1990). Communication, of which student discourse is a part, is so important that it is one of the standards of learning level (NCTM, 2000).

Talking about mathematical concepts allows students to understand and critique the ideas of others while reflecting on their understanding and ideas. The mathematical ideas can be grown, integrated, and updated through the collaborative learning environment, and the students can make assumptions, combine previous knowledge with current understanding, reason about mathematics, modify and improve their approach, and take ownership of their mathematical knowledge (Kersaint, 2015). Talking about the classroom discourse in mathematics, it is clearly understood that the teachers about the benefit of students with little things such as the meaning of technical words, symbols, pictures, physical models, and techniques to present and defend their ideas.

Student-friendly classroom discourse in a mathematics classroom is a two-way dialectical discourse between the teacher and the students in which the teacher is not only providing instruction and guidance but also actively engaging the students in the learning process. The teacher should encourage students to ask questions, provide feedback, and explain their reasoning. The teacher should also create an environment where students can collaborate and learn from each other.

From the continuous collaboration with mathematics teachers of four community schools of Kathmandu Valley, mathematics educators, and head-teachers, several things in the classroom were going on and had to be followed to promote the student-friendly classroom discourse. In the interview taken with my participants such as mathematics teachers, head-teachers, and mathematics educators, I generated the following themes.

Learning from Collaboration

Communication and interaction in the mathematics classroom are critical elements for learning mathematics with understanding. When students are expected to contribute and support these contributions to the mathematics discussions, they are allowed to build a clearer understanding or model of the concepts being discussed. Mathematics class discussions, then, can be rich opportunities for students to engage in mathematical activities such as hypothesizing, problem-solving, explaining, and justifying (McCrone, 1997). In the collaborative classroom discourse, there is the interaction between students and teacher, or students and students. When students interact with the teacher or when students interact with one another, they are given opportunities to test the viability of thoughts, ideas, and conjectures. When students interact with one another, the teacher should provide the authority of interactions in the classroom. If the students are afraid of teachers, then productive discussions among the students cannot be exercised. There should be a free but controlled environment and appropriate subject matter for classroom interactions. In this context, a mathematics teacher expressed his experience.

> *I always encourage students for actively participate and interaction with me and among themselves. Students have their own nature which is difficult to change. In my experience, I have found three types of students in the classroom. The first group of students is talkative, interactive, collaborative, and asks everything with the teacher and their colleagues if they do not understand or if they want to learn more extra things. These types of students sometimes make the classroom noisy and may lead the interactions out of the subject matter. The second group of students does not take part in interaction activities by themselves unless they are forcefully asked to solve some problems. If they are given opportunities in a mathematical talk by indicating personally, they greatly contribute to their friends too. The third group of students tends to feel inferior or minority to themselves and try to hide the fact. While working in a class, if*

> *the teacher approaches them, they get afraid and make their work incorrect. My focus is always on all the students to give them an equal opportunity to discuss and learn. However, classroom discourse is necessary to develop the overall progress of the students.*

From the above verbatim of my mathematics teacher participant, I claim that there was a problem in the classroom with the interaction of students. The teacher shared that he experienced three categories of students in his classroom of different natures, self-participatory, forcefully participatory, and non-participatory in collaborative interactions. The teacher often tried to participate all the students in the discussions. Although there were different types of student engagement, the students' collaboration is one of the important aspects of good classroom teaching in mathematics. The collaborative work of self-participatory, semi-participatory, and forcefully-participatory helps in learning through the active engagement of the students via discussions, questioning, and concept mapping. In the same context available research (Forman & Cazden, 1985; McCrone, 1997; Ormell & Pimm, 1989; Vygotsky, 1978) on student-student interactions supports the belief that true collaborative work provides opportunities for student learning.

Students are allowed to interact enough collaboratively but it should be somehow controlled and oriented to the learning of the specific subject matter, otherwise, the discussion diverges into unnecessary talks and becomes only a noisy environment. The teacher should decide whom to allow to participate in a dialogue and whom to wait in a queue. The teacher should decide based on the student's level of preparedness and the relevance of the dialogue to the lesson. The teacher should also consider the student's ability to contribute meaningfully to the dialogue (Forman & Cazden, 1985). The teacher should also take into account the amount of time that is available, as well as the student's interest in participating. Finally, the teacher should ensure that all students have the opportunity to participate in the dialogue, regardless of their level of preparedness or interest. The teacher is taken as the referee of the classroom who manages whom to call for participation by asking necessary problems and whom to control from extra orchestration. Beyond the colligative interactions in the classroom, Leder (1987) suggested focusing on, the type of participation opportunity provided to students; the level of questions asked by the teacher; the nature of students' responses; the type of feedback from the teacher and other classmates; length of time engaged in the interaction; and frequency of interactions between the teacher and particular student.

Creating an Appropriate Environment for the Student Participation

Student participation is a very important factor in classroom discourse on mathematics. When engaging in classroom discussion activities, it is especially important to create a learning environment that is supportive, positive, communicative, and understandable. To provide students with a safe and engaging learning environment, teachers need to work with them to create group interactions that set the standard for classroom discussions. Teachers need to think about their role in discussions, work as facilitators, and develop multiple perspectives on teaching and learning. Students enjoy in creative activities such as paperwork, project work, measurement, calculation, and group work, rather than monotonous listening. An educator, who was a mathematics teacher twelve years ago and working as a resource person at present, expressed his reflection on collaboration and teamwork during the classroom discourse.

> *The first thing is students should be able to confidently ask what they think is difficult. This type of conversational environment is organized in the classroom.*

> *So, the teacher should divide the students into small groups and let them solve the problems themselves first. Students are advised to do whatever they want and the way they want, even if it goes wrong. They feel free to solve the problem and actively participate. However, if someone does not solve it well, the teacher should not worry about it but the teacher should be happy that his students have tried hard, actively, and enthusiastically.*

The educator meant that the teacher should organize the debatable environment in the classroom and students should be divided into small groups so that they can interact among themselves about the given problems. The problem should be given to the students to solve themselves for the first time. The teacher should not solve it for students at first or make them copy from a readymade solution. This increases the student's logical ability. When one thinks of new things, s/he develops the power to think accordingly. Students should be allowed to make mistakes and should be allowed to learn from the same mistakes or should be taught from mistakes. Then only learning is sustainable. Students may not be able to solve problems spontaneously unless they are not afraid that they will make mistakes. If they are afraid that the teacher will scold them while discussing with their peers, they will never get involved in an interaction. Students need to be in a free and fearless environment in which they can find solutions to their problems through independent discussions in the classroom (Barker, 2014). The teacher should teach the student to solve the problem correctly only when the student seeks help. Collaboration and teamwork are the self-dependent processes of learning mathematics from peers rather than being dependent on the teacher.

Kelly (2021) believes in Franklin's saying, “tell me and I forget, teach me and I remember, involve me and I will learn" and argues that collaborative learning benefits the most. Learning with collaboration is the sharing of ideas of multiple friends from different cultural backgrounds and it is often said that “two (or more) heads most certainly are better than one". Collaborative learning teams are said to attain higher-level thinking and preserve information for longer. In this respect, Vygotsky's sociocultural theory (1987) argues that students’ ability to solve problems is enriched by knowledge acquisition and collaboration with peers. The zone of proximal development considers that if collaborative learning with peers is increased the student's awareness of other concepts will also increase. Learning is social. Those who develop good social skills go on to become very successful in life as they can deal with people and have a sharper emotional quotient (Kelly, 2021 May 19). Collaboration is a learning process, if managed correctly, it is a powerful tool that can allow learners to tap into new ideas and information. It allows for challenge and differentiation, enhances confidence, and self-esteem as well as strengthens social skills. Gardner (1983) in the theory of multiple intelligence states that humans have not one but up to eight types of intelligence (musical–rhythmic and harmonic, visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinaesthetic, interpersonal, intrapersonal, naturalistic) and, this intelligence probably develops from the collaborative and cooperative work.

Student-centered Classroom for Student-Friendly Discourse

A student-centered classroom, or student-centered learning environment, is one where the focus of instruction is shifted from the teacher to the students, with the end goal of developing students who are autonomous and independent, by placing the responsibility of learning in the hands of the students (Loveless, 2013, May 20). The student-centered pedagogical activity is taken as one of the most effective ways to help students develop the skills required for independent problem-solving and lifelong learning. Learner-centered education is activity-based, inquiry-based, and problem-based learning which is widely promoted internationally as an example of 'best practice' pedagogy (Schweisfurth, 2013). In the student-centered learning environment, the interest of the students' takes centre stage and the teacher gives students choice and voice, finding ways to provide learning experiences that focus on what students value and students play an active role in the classroom discourse. In this respect, a mathematics teacher expressed her experience of classroom discourse in the mathematics classroom.

> *Today's classrooms are student-centered. There is freedom for students to discuss a problem faced by them in classroom teaching as well as in everyday life. We cannot do anything against the student's interest. When I am solving a mathematical problem on the board, students spontaneously demand where and what to explain, which step is to be solved alternatively, and how many problems are to be solved in the classroom. If we give them more homework on any day, they unitedly refuse to complete it at home. They become happy doing in the group of friends in the classroom under my assistance.*

This shows that students enjoy a free learning environment. The teacher claimed that students can freely make the best decision about the classroom assignment, home assignment, and how much is studied in the classroom. The student-centered activities increased the decision-making habits of students about the classroom activities.

Blumberg (2016) explains several opportunities given to the students in student-centred classrooms as 1) children are given access to modern facilities like computer education according to their grade level; 2) individual attention is given to overcome learning difficulties through learner-focused teaching; 3) students are given opportunities to learn through collaboration, teamwork, fieldwork, experiment verifications, practical involvement, and discussions with expert teachers to improve cognitive and logical power; 4) providing students with opportunities to participate in local, regional, and national level competitions to show their talents; 5) monitoring and evaluation of every teaching and learning activity is ensured through internal and external institutional support; 6) learning achievements are shared with parents, community and supporting institutions to encourage children to excel in curricular and co-curricular activities; 7) high achievers, competition winners and runner-up are appreciated in the community programs to boost their morale; 8) every event or activity is organized around learners' development and is well justified.

Every student adjusts his/her mental model to incorporate new experiences and make sense of this new information, and his/her schema is constantly readjusting through collaborative learning in the student-centered classroom (Atherton, 2010). Froyd and Simpson (2010) emphasized that in a student-centered environment, the knowledge of learners influences future learning; and this can be in mathematics or other courses where calculations and application of concepts are needed. In addition, strong, committed teamwork and positive interaction among members and other colleagues are all catalysts to students’ retention of information (Zain, Rasidi, & Abidin, 2012). A student-centered classroom is the concept of a constructivist environment where every individual contributes in constructing knowledge through group work, collaboration, and cooperation.

A head teacher expressed his views on the student-centered classroom as;

> *The school has been conducting various programs for educational improvement. …teachers have to go to the classroom with a mandatory teaching plan. Students are involved in project work to enhance teaching and learning. Students are taught using different materials and …. not just textbooks.*

> *Emphasis is placed on teaching-learning activities using entertaining and exploratory methods using information technology in teaching-learning activities. In the course of teaching mathematics, we have been taking the students to the mathematics laboratory. ...children in small classes are taught through sports and music…. In addition, the students are encouraged to organize an "educational exhibition" once a year based on the skills, they have learned throughout the year... strong physical condition of the school…. establishment of social relations…. Child-friendly school environment…. efficient economic condition*.

A school's head-teacher claimed that the school had conducted various programs for the educational improvements in which teachers and students had to follow some mandatory activities from their sides. From the teacher's side, they would teach with fully planned activities, project-based learning, classroom discourse using teaching materials, and teaching-learning activities using entertainment and exploratory methods using information technology. Mathematics laboratory and science laboratory would be used to provide practical knowledge and skills in technical subjects like mathematics and science. Sports and music were added to the pedagogic activities to make learning entertaining, sustainable, and student-friendly. The school would provide a strong physical condition of safe drinking water, a clean toilet facility, a library facility, a science and mathematics laboratory facility, child-friendly school environment. These facilities would certainly fascinate student-centered learning. From the students' side, they should actively participate in the educational exhibition, project-based learning, and optimum use of the library, mathematics, and science laboratory to enrich their knowledge collaboratively and individually.

O‟Neill and McMahon (2005) argued that in exercising the student-centered class, resources are a very important factor along with committed teachers with knowledge, skills, and expertise. These all factors are interconnected and have a huge impact on learners. However, only so-called enough facilities, and working with limited resources is a challenging and exasperating situation rather than enjoying the teaching and learning. In such a situation, quality education standards do not match the evidence of actual practice. Thus, the huge gap between ground realities and the claims of the provision of necessary facilities to community school children puts a big question mark on the policymakers and stakeholders (Cheong, 2010; Piert, 2013; Qutoshi & Poudel, 2014). In this respect, the theory of cultural capital (Bourdieu, 1973) is applicable. In the student-centered classroom, the teacher becomes a facilitator and organizer whereas students become active participants in their learning in the condition of full of resource mobilization. The teacher's works are based on the student's cultural capital, i.e., the accumulated wealth of experience. And what students already know, what knowledge they can discover is well taken by the teacher. The teacher encourages students' participation, recognizes their strengths and weak points builds on the values and interests of the students, and asks them to give their comments (Gilia, 2016). In an interactive pedagogy classroom situation, the teacher plays the role of mentor, modelling how to share knowledge, helping students to generate new ideas, and hence learning becomes an individual-based as well as a collaborative experience.

Creating a Fearless Environment

"Teachers can’t teach scared.
Students can’t learn scared.
Principals can’t lead scared."

Edelman (2018)

Students learn better when they are not afraid to take risks and make mistakes. Fear is the great slayer of teaching and learning (Edelman, 2018). There are various factors in the classroom at the beginning of the new session in the school on which students often become fearful. Some students are newly admitted to the school and they fear the new environment of the school. And, of course, there are not many friends with whom they can talk. They cannot share their problem with unknown classmates and teachers. Especially, older students of the school does not value the newcomers in the school quickly because they are also strange to the newcomers. Therefore, one type of conversation gap exists and unknowingly students suffer from fearing conditions. Some students are upgraded from the same school but meet with new teachers with new habits. Many students experience varying degrees of anxiety or fearfulness. Sometimes, as a teacher, I have also realized that some of the newcomers would suffer from a sense of nervousness among other students if they were just told to introduce themselves. Their facial expression, body language, and murmured voices would be enough to feel that they are facing difficulty and acting strangely in the classroom. Most of the students settle shortly, but some may remain consistently fearful. It is possible that their high level of fear negatively affects their ability to learn in the classroom from week to week. Some students fear teachers dominating character or power in the classroom and they hesitate to ask anything if they find difficulty while classroom discourse is going on. Some students feel inferior minority and cannot take part in classroom activities actively, spontaneously, and joyfully.

Regarding Bledsoe and Baskin (2014, 2015), humans normally experience fear starting at an early age, and as they grow older, they develop resources to manage and overcome this feeling. Those who believe they are physically inadequate, have inappropriate schooling, or lack encouragement, develop a chronic feeling of worry and apprehension, and this constant fear can hinder learners' attempts to understand the information that is required for academic success. In such a situation, classroom teaching won't be fruitful for the students as well as teachers. Therefore, the teacher needs to find out the fear factors of students and try to minimize them. A mathematics teacher voiced his experience in the classroom.

> *Students are scared of petty things. They are terrified of their performance because of the perceived danger of failure. Students are always worried that the little success they have achieved will also decrease in the upcoming exams. Some students always compare themselves to others in the class and consider themselves weaker than others, which is why they are always afraid of their weaknesses. Some of them are afraid that their peers will make fun of them if questions are asked by the teacher about the content that is not understood in class. They are afraid to ask the teacher openly what they don't know. Most of the students are scared of exams.*

One of the mathematics teachers accepted that students are sometimes scared in the classroom. There are various reasons for their fear. Students are scared of petty things. Some students are also worried that their results will be poor in the next test, which seems to be possible because if students are worried about their exam, they cannot do better in the next exam. Students compare themselves to their classmates and if they feel weaker than others, they feel humiliated because of their weaknesses. Some students even hesitate to ask questions to the teacher feeling that friends would laugh at them. There exist some common types of student fears such as performance-based anxiety, fear of failure, fear of being laughed at, and cultural components of fear that impact learning (Bledoe & Baskin, 2014). We have a saying "nabirā'unu naḍarā'unu"

[नबिराउनु, नडराउनु][29], but it was found that students fear without any mistake. Therefore, it is necessary to create a fearless classroom environment to promote classroom discourse.

The fearless classroom layout allows constant flow and collaboration-conducive vignettes offer a learning environment rich in language, cooperation, and productivity (Barker, 2014). A fearless classroom environment can be created by managing or designing small group works consisting of imagination, curiosity, adaptation, and passion for the students. Teachers should be creative and think about how they can provide real-world opportunities for students to explore and use their learning in meaningful ways. Artistic students may want to draw different pictures of geometry, students who are able in linguistics can explore arithmetic and the ones who are good at imagination can explore abstract algebra and trigonometry. The ideas, struggles, successes, failures, and questions still lingering, is the magical moment where every student feels validated and needed as a contributor to the greater learning of the classroom (Barker, 2014). From this perspective a resource person, who had taught mathematics for more than a decade said,

> *……. in fact, the teacher should never scold the students and encourage them to do more even if they are not able to do their homework on time. Pointing out any mathematical problem, the teacher should not say "it is difficult and you cannot do it". It is better to say "first of all you try it and if you cannot do it, I will help you". If students are unable to solve any problems or follow their mistakes, it is better to teach by making small groups of students. If any student does not complete his/her homework in time, it is necessary to investigate incompleteness or undone rather than torturing for an incompletion.*

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[29] Nepali script which means "do not make mistake, do not get feared".

The ex-teacher claimed that teachers should be aware of the reputation of the students in the classroom and encourage every student to do the classwork and homework assignments. If any of the students are unable to complete their assignments timely, the teacher should provide more time to complete them to motivate them to learn. Students often make mistakes while solving mathematical problems but the teacher should not be worried about it and should teach making small groups in the classroom so that students understand everything and can solve the problems independently. Students are to be investigated if they are unable to complete their work on time to find out the real problems faced by them behind the incomplete assignments. Teachers should try to make students tension-free by creating a student-friendly environment in the classroom.

The next mathematics teacher expressed,

> *Students frequently suffer from exam phobia. Few students get scared as soon as they listen to the name of the "exam" So they need to be treated positively. The informal talk about the interests of the student, the profession of parents, family members, etc. can make a student-friendly environment in the classroom for teaching. Students are not terrified by saying "examination would be difficult and an awkward question paper will be created". Some students worry once they hear the word "exam".*

An examination is one of the essential parts of the teaching-learning process. In our schools, the exam is taken to evaluate the students and only one or two exams measure the efficiency of the students to complete one level and be able to study at the next level. Therefore, students are in tension about examinations due to fear of failure. In such a situation, teachers should not terrify students by saying that the examination would be difficult. To minimize the fear of students in the classroom discourse, Donlan, Loughlin, and Bryne, (2019) have advocated four things and are climate, content, practices, and assessments.

The classroom climate reflects a sense of warmth and support for learning. A common emphasis on inclusive classroom open communication, collaborative relationships, and the promotion of educational progress is considered to have a positive climate. When students feel that this is supported, they are more likely to ask questions, seek help, help their peers, engage deeply with the materials, and achieve academically. Content refers to which category of course topics are covered. Research indicates that students are more successful when the course materials are appropriate for their developmental stage and academic ability (Donlan, Loughlin, & Bryne, 2019). Some teaching methods are more suitable for learning than others. Students with clear expectations and timely feedback are encouraged them to participate and learn because they have a better ability to do so. Supportive, positive, and responsive teaching methods help to create a fearless teaching environment in the classroom. Learning assessments are best after they are valid, reliable measures of expected learning outcomes. Assessment structures promote learning when they offer time for feedback and growth and embody various ways of understanding. Transparent, gettable expectations facilitate student belief that success is feasible and devote higher levels of effort.

Engaging Every Student in Mathematics Discourse

Student engagement refers to the level of attention, interest, passion, optimism, and curiosity students display when studying or being taught, which extends to the motivation they have to learn and the progress needed to be seen in their learning (GER, 2020, May 31; Lee, 2014; Skinner & Belmont, 1993). To support students, teachers should help students create a vision of expected behaviours and actions, prepare them for their roles through modeling or role-playing, and consistently reinforce those behaviours. Mathematical growth and they become better able to express ideas coherently and to use vocabulary, syntax, and semantics accurately (Dary, Pickeral, Shumer, & Williams, 2016; Kersaint, 2015). Teachers need to observe, listen, and monitor students to aid in classroom decision-making. When to intervene and when to broaden student thinking provides an opportunity to understand student thinking, monitor, growth, and evaluate knowledge. In an engagement and discourse-rich classroom, teachers do not just get an insight into what students are doing but also the approaches they use, how and how well they understand the ideas, and how they present their mathematical knowledge (Krause, 2005). In a mathematics classroom, every student either individually or collaboratively should discuss, read, write, draw, debate with peers, etc. to enhance their knowledge continuously.

According to a mathematics teacher,

> *I always force my students to do something in the classroom. I believe in learning by doing. Students should not sit idly in class. I have always encouraged students to actively participate in classroom activities, but some students try to deceive me through classroom activities. If I look at them differently, they will change their attention here and there. I know exactly what the students in the class are. I always look at students who are relatively weak in class and often lose interest.*

The teacher believed that the engagement of students allows his students to complete their classwork thoroughly and realized that they have no late conversations or any other alternative for productive lectures in class. Students were well-known in the classroom for their unique behavioural activities. In the teaching process, the teacher treated them according to their characteristics. Students who were talkative outside of the course were prone to lose focus and contact due to unproductive things such as personal revelation or dialogue about songs, movies, video games, etc. Inattentive students were worried about doing homework and were motivated to participate in class activities so that they could learn more in class. Every student was known for being clean, positive, good at problem-solving, curious, hardworking, social, behavioural, polite or slow, having problems, having different skills, impolite, aggressive, etc. Students who were relatively slow, problematic, diverse, low-educated, and aggressive, were also concerned because they needed special care and understanding separately. One of the head-teachers expressed his views on students' habit management as follows.

> *I think teaching is one of the most difficult and challenging tasks. The teacher should act as an actor according to the classroom situation and the mood of the students. Teachers should play a multifaceted role in understanding students' interests, behaviours, and cultures. This is more difficult. Teachers should teach students to understand the real-world problems they face, and how to properly solve these problems. In my experience, we need to understand their feelings and love them accordingly, rather than yelling or punishing them. Students' family background, economic status, social background, hobbies, positive and negative aspects, likes and dislikes, cognitive level, parent contact information, personal resume, etc., I keep as much as possible. It's easy to treat each student with ease and involve them in classroom activities.*

Students like the experience of teaching in the classroom, which is to gradually get to know the students at a cognitive level and motivate them accordingly. The principal makes sure that teaching is the most difficult and challenging task, and that the teacher plays an important role. The versatility depends on the classroom conditions and the mood of the students. Teachers need to personally understand students' interests, behaviours, and culture, which is difficult to follow in practice. When teachers understand the problems in the real world, students face and try to solve these problems, then every student will participate in teaching activities. Understanding how students feel is more important than shouting or punishing them. Students' personal information, such as family background, financial status, history, hobbies, positives and negatives, likes and dislikes, etc., can help students win their teamwork individually or together.

Chickering (1991) states that mathematics education is not just like a fascinating sport. By simply sitting in the classroom, listening to the teacher, memorizing the prepared homework, and vomiting the answers, students will not learn much. They should talk about what they have learned, write it down, connect it to the previous experience, and apply it to their daily life (Toor & Mgombelo, 2017). According to Filding-Wells and Makar (2008), in the school environment, emotional participation can be seen as the beliefs, attitudes, and emotions experienced by students. All aspects of effective participation are seen as fear, interest, boredom, achievement orientation, and frustration. Fredricks et al. (2004) define behavioural participation in three ways. The first is similar to positive behaviour, follow the rules, and follow the code of conduct. The second is through a certain amount of hard work, perseverance, concentration, attention, questioning, and communication; finally, as the school's obligation, it can be reflected by the student's participation in extracurricular activities and other measures.

Vygotsky believes that knowledge is culturally constructed through interaction and engagement with materials, and social agents such as peers and teachers (Shabani, 2016; Vygotsky, 1978) because the learning environment is arranged flexibly with classmates or a naturally existing atmosphere. By stimulating student-teacher interaction, the social learning structure is essentially a representative structure of society. In addition, the socially constructed environment so-called "classroom" encourages problem-solving, collaboration, and teamwork by arranging the space for freedom and full engagement to grow the cognitive level and skills of unpacking societal problems through the knowledge of mathematics exercised in the classroom (Herman, 2008, 2015). Vygotsky (1978) pointed out that “generally speaking, the main characteristic of human behaviour is that people personally affect their relationship with the environment and through this environment, they change their behaviour and bring it under control” (p. 51). In a similar context, Liu and Matthews (2005) recognized the working philosophy of education and pointed out that student engagement is crucial to the influence of people who adopt constructivism and collectively accumulate knowledge in their work.

Allow Students to Create their Own Problems

When students create their word and number problems, they will associate mathematical concepts with their previous knowledge and life experiences. As a particular way of communicating in mathematics, students create or ask questions that encourage creative thinking, constructive meaning, and the application of procedures and conceptual methods according to the cognitive knowledge level of students (Digital Promise, 2020, May 12). The classroom can be used as a platform for students to create and share their problems. Due to the power of dynamic rendering technology, problems related to geometric reasoning are particularly important. Seeing and solving problems written by peers stimulated motivation and enthusiasm for learning (Digital Promise, 2020, May 12). In the Nepalese context, teachers mostly teach how to use various problem-solving methods to solve textbook problems, but they are unlikely to ask them to solve their problems. Students like to solve their mathematics problems and need to understand that when asked to create a mathematics problem, they need to think about more than just solving the problem. By increasing logic, thinking, and cognitive abilities of thinking, this process enriches students' knowledge of mathematics. In a similar context, a mathematics teacher told his experience of classroom teaching.

> *Sometimes, I ask students to develop their problems when teaching mathematics topics. Students enjoy asking different types of questions about their self-imagination. Students are interested in solving their problems and are asked to solve the problems in groups and share the problems they have solved. I often ask my students to make the questions for the mathematical quiz context that is held in the classroom by dividing students into small groups. Students motivate themselves to ask questions in front of their classmates.*

My participant teacher said that he asks his students to create their problems rarely when the mathematics lesson is finally over. He assured that students enjoy and actively participate enthusiastically in making different types of problems of their self-imagination which is seen as the understanding of the taught lesson carefully and the construction of new knowledge underpinning the new problems. When students construct a variety of problems, the teacher asks them to exchange the student-made problems in small groups solve them, and share them among the groups. Students are supposed to solve the self-created problems by employing the multimethod and the teacher facilitates students in solving the real-time and real-world problems of experienced students. Regarding the same, Silver et al. (1996), when students start to pose and discuss their original mathematics problems, their views on the topic will change dramatically. If one spends time researching these topics, his/her mastery of the experience will generate excitement and motivation. Participation in discussions and exercises surely helps students expand their problem-solving skills and enhance the habit of developing new problems (Bonotto & Santo, 2015). However, asking questions is more important than solving existing problems. Through structured learning, students can also better assess the interest and productivity of their new problems. As students become more demanding, their homework shifts from aimless changes to clearer mathematical goals such as exploring the relationship between two different areas of interest.

Nowadays, mathematics requires not only computer knowledge but also the ability to think and reason in mathematics to solve new problems and explore new ideas that students will encounter in the future (Bonotto & Santo, 2015). By planning and promoting courses, teachers can actively engage students in mathematical thinking. Their strategies and processes for solving mathematical problems combine their daily language with special mathematical vocabulary. Students need to understand how to communicate in mathematics, provide reasonable mathematical explanations, and justify their decisions. Effective teachers encourage students to share their knowledge of this idea through oral, written, and useful methods. By listening to the opinions of students, teachers can better understand what their students know and what misunderstandings they have. These misunderstandings have opened a window to the learning process of students. Effective teachers view thinking as a process of understanding. They can use the students' thinking as a resource for further learning.

The next teacher expressed his experience of classroom teaching with student-made problems, *I often teach my students by demonstrating the teaching materials. I believe that the way of making abstract mathematics is from concrete materials and artefacts. I encourage interested students to prepare learning materials in groups or individually and make fruitful use of the effective materials created by students in the classroom or in the next class. These materials are also used in educational exhibitions. At the end of each chapter, I ask my students to prepare a few questions, and I usually ask about the problems caused by the students in the unit test, class test, and decision test. To make questions, students need to know problem-solving methods, problem types, and solutions. I have learned from personal experience that problem-posing in the classroom can improve student practice at home and school collectively or individually...students like to do it...they are motivated to do it.*

According to my participant mathematics teacher, making students construct teaching materials as well as questions after the classroom discourse of each chapter, students enjoy the activity enhancing and creating a student-friendly environment. Problem-posing activity increases the self-practicing habit of mathematics individually and collectively among the students. To make a question is to solve a question with the application of different methods. The importance of the ability to create mathematical questions means that the development of mathematical skills requires mathematical imagination skills. Among other things, problem-posing skills can be developed by asking new questions, creating new possibilities, and examining old problems from a new perspective (Puspitasari, et al., 2018). Since problem-making activity is triggered by context and compared with existing knowledge, problem definition also directly improves the ability to existing knowledge. Therefore, students need to practice their mathematical problem-posing skills so that they can develop critical and logical thinking skills, problem-solving skills, and other high-skilled mathematical thinking skills (Bonotto, 2013). Therefore, one of the ways of promoting classroom discourse in mathematics classrooms is with the involvement of students in the problem-posing activity.

Mathematics is a subject that is difficult for many students because it is an abstractly organized context. One of the main reasons why students struggle with mathematics is that textbooks do not always meet students' learning needs (Nugroho, et al., 2021). The main contribution is the compilation of mathematical exercises that use multiple intelligences (Gardner, 2011) to improve normal levels. Teachers can use different bits of intelligence in mathematics classes in a variety of ways, to meet the demands of all students individually. By using eight different intelligence and implementation techniques, teachers can easily help students develop better learning and thinking skills. According to the theory of multiple intelligences (Gardner, 2011), human beings have eight bits of intelligence from birth, but not all intelligences have the same advantages for everyone. In the same classroom, a teacher has to meet students of different bits of intelligence, therefore, to foster all the students of varieties of intelligence, characteristics, socio-cultural backgrounds, and cognitive levels, a teacher must carry out all the possible mathematical activities in the classroom together, one of which is problem-posing.

Suitable Discourse in Mathematics Classroom

Almost, every student has a fear of mathematics due to the complexity of calculations and theorems, but it could be their favourite subject if they approach it with a positive frame of mind and aptitude (Khan, 2019). Classroom discourse refers to the language that teachers and students communicate with each other in the classroom to transfer existing knowledge or generate new knowledge. Speaking or communicating is the medium in which most learning takes place, so the study of classroom discourse is the study of the process of face-to-face interactions with logical thinking (Bondurant, 2020). According to Khan (2019), Posamentier (2017), and Todd (2019) there are mainly two ways to teach mathematics in the early stage of students namely "the worst and the best". The worst is of course that students use mathematical equations as a daily task, just like walking around a field without letting them play. The best is of course involving the students in practical work and making the subject interesting. With the aid of visuals, mathematics can easily become interesting. However, the main problem is that teachers need to be dedicated to mathematics. In this regard, my participant teacher said,

> *I also know that students like to do different activities in class instead of only solving problems. But what to do, solving problems is the requirement of the exam and the students who can solve these problems are considered good students. Classroom teaching is necessary to meet the evaluation criteria for the examination. Students are taught so that they can easily solve the problems given in the summative assessment.*

Whereas the mathematics educator's view was;

> *What a teacher must understand is that everybody does understand not everything, and thus cannot solve it as well. First, a teacher has to decide what kind of student s/he is going to teach and then the teacher should plan accordingly with an adequate number of activities. For example, if a student is not able to learn geometry, s/he ought to be motivated to learn, however, it's not necessary to teach by rote learning anyway, but if s/he can learn algebra well, s/he should be taught with emphasis. If students are taught how to walk; they will learn how to run.*

From the interview with my participant teachers and educators, I came to know that teachers mostly try to teach the textbooks and make students do the problems given in the textbooks. The evaluation of students is carried out by applying different methods such as asking verbal problems, formulas, the meaning of symbols, making students do on the board, presentation, project-based work, home assignments, classroom assignments, unit tests, class tests, surprise test, etc., which help teachers plan the lesson accordingly. These formative assessments are used to monitor students' learning and provide ongoing feedback. For summative/decisive assessment, teachers set the question papers guided by the curriculum and also based on students' performance. Then, they are evaluated and upgraded for the next class. The eligibility of the students is mainly measured with the summative assessments in the case of the Nepalese curriculum. Therefore, mathematics teachers emphasize problem-solving based on the format of summative assessment because students are not finally evaluated through the methods of formative assessments. The mathematics teacher claimed to prepare the student for the capability of summative assessment stating "Students are taught so as they can easily solve the problems given in the summative assessment". But mathematics educators claimed that students show a better performance on summative assessments if they show better performance on formative assessments full of classroom activities by saying "If students are taught how to walk; they, themselves will learn how to run". Here, I found that mathematics teachers’ and mathematics educators’ views were contradictory in some cases of classroom teaching according to their experiences.

In the same context, Meghali (2020) claims that the main reason why children are not good in mathematics is that they cannot visualize mathematical concepts; labeling a child as "weak in math"; rote learning methods – where a child is given formulas and statements to learn by heart; the pressure of scoring good grades; a fixed mind-set; and exam-oriented teaching. The theory of multiple intelligence (Gardner, 2011; Karamikabir, 2012) emphasizes that the role of the teacher is to establish the relationship between various components of the argument and intelligence. Therefore, when students enjoy learning, active types of cognitive intelligence, and continuity in mathematics class, the teaching method changes from one type of intelligence to another. The use of words, pictures, gestures, rhythmic phrases, flashcards, symbols, and formulae as story-making, and exam-free learning from cultural experiences make everyone better understand. It is important to know that teachers should never classify the child as weak or strong. Unfortunately, parents and teachers often do this.

According to researchers, (Gardner, 2011; Khan, 2019; Meghali, 2020; Todd, 2019) students who are considered weak, when they are young, usually perform poorly throughout their academic careers. The "weakness" is rooted in their minds. On the other hand, a student who has always been admired for being "strong" in mathematics may become confident and may not make enough effort to move on. Therefore, teachers need to get rid of this unchanging mind-set - classify children into categories with firm abilities and turn to a growth mind-set that each child's abilities are unique and different and must grow. When teachers analyze the root cause of why children have mathematics problems, they find that it is almost entirely related to how children learn mathematics or how to teach math. Mathematics is a subject that can provide any child with a playground free from fear. Unfortunately, children are exposed to mathematics and memory from a very young age. It is not surprising that many children resist mathematics because what they learn in the name of mathematics is not mathematics. So, they do not struggle with real mathematics but struggle with the imperfect version of mathematics they usually learn in school.

Advocacy of Using Multicultural Pedagogy

Nepal is a multicultural, multilingual, multi-ethnic, and multi-religious country (MoE, 2016); and each ethnic group has its own religious, social, and cultural beliefs and values. Nepal is a land of diversity in topography, biodiversity, language, caste, race, religion, and culture. About 29.14 million people in this country are divided into 142 castes/ethnic groups speaking more than 124 languages, and following 10 religions (CBS, 2011, 2014, 2022). Therefore, Nepalese schools are filled with students of different societies, cultures, races, languages, and many more. According to the Nepalese Constitution (2015), every child has the right to learn in their mother tongue, but this has not been implemented in practice. Minority ethnic groups (such as Kami, Sarki, Pode, Damai, Badi, Lohar, Chamar, Sunar, Halkhar, Muslim, Thakali, Bote, Raute, Hayu, Jirel, Kusunda, etc.) students are different from mainstream groups in their mother tongue and/or many other cultural traditions. Therefore, respecting and solving cultural issues in education provides equal opportunities for students of different ethnic backgrounds. In a multicultural classroom, everyone should have the opportunity to analyze and evaluate mathematical thinking and strategies. In such a class, intercultural communication and multicultural values are very important, so it is very necessary to formulate courses and mathematical pedagogies that support and include the overall students of the classroom. NCTM (2014) advocates multicultural mathematical pedagogy by raising the voice as – creating, supporting, and maintaining a culture of accessibility and equality requires being sensitive to learners' backgrounds, experiences, cultural views, traditions, and knowledge when designing and implementing mathematics courses and assessing their effectiveness (Brown et al., 2018). Communication among students in groups is essential to ensure that all students have the opportunity to receive high-quality mathematics courses, learn challenging mathematics materials, and obtain the support they need to succeed. To ensure equal opportunities and challenges, it is important to ensure that all students acquire mathematics skills and increase the number of students with the highest mathematics skills from all races, ethnicities, languages, genders, and socioeconomic backgrounds.

One of my participants' teacher's voices about multicultural mathematics pedagogy was,

> *Teachers have to be aware and neutral toward races, ethnicities, religions, and socio-cultural and socioeconomic issues. They should not support or oppose anyone. In my experience, once upon a time, I used the word "temple" in teaching height and distance. Some of the students who were unrelated to this word felt uneasy. By knowing this, I used the word "pillar" instead of "temple". Nowadays, when I want to use religious vocabulary like this, I know very well that I will never forget to say "You can substitute alternative words for.... and you can change your question without changing the mathematical expressions.*

I found that mathematics teachers are aware of racial, religious, ethnic, sociocultural, and socio-economic issues. They are neither supporters nor opponents of the religious vocabulary while teaching. Supporting all the issues of the communities like ethnicity, religion, sociocultural, socio-economical, lingual, etc. is one of the ways to be a multicultural mathematics teacher in a multicultural classroom (Osorio, 2018). On the other hand, being neutral to all these issues is also one of the ways of being non-controversy in the multicultural mathematics classroom, which is not possible in practice because the teacher is also one of the members of the community. Therefore, it is better to support all the social, racial, religious, lingual, and economic issues very carefully instead of being neutral in the multicultural classroom.

In the interview of my participant teachers, they also advocated the multicultural curriculum, textbooks, and teaching materials.

> *Since mathematics textbooks are designed as the direction of the curriculum and mathematics teachers teach textbooks furnishing with teacher's guide, teaching materials as well as integration of the ICT. Therefore, mathematics curricula and textbooks should also reflect the multiculturism of our society. In my case, I always motivate my students to prepare the teaching materials in a group or individually so that the teaching materials become multicultural. I respect students from every culture, language, and religion.*

In the conversation with me, the mathematics teachers said that they respect the unique identity of each student in terms of culture, language, and religion. They also encourage students to create classroom materials because they believe that the classroom materials created by students can come from a variety of ideas. They think this is also a way to respect students and their culture. Mathematics teachers also claimed that mathematics curriculum and textbooks are the major sources of mathematical knowledge and they should incorporate multiculturism reflecting our diverse society. Mathematics teachers strongly advocated that they are only the medium of knowledge transfer from mathematics textbooks to the students by applying multimethod pedagogic strategies. If the mathematics curriculum and textbooks reflect the multicultural society, then only teachers play the role of multicultural mathematics teachers. Mathematics teachers also complained that they have never received any pre-service and in-service training on multiculturalism, but they are understanding and protecting the multiculturalism of the society through mathematic pedagogy as much as they know.

From the multicultural perspective, Devkota (2013) also claims that Nepal is a multicultural country based on race, linguistic identity, geographic identity, religion, race, belief, and politics. In Nepal, it is believed that the caste system was introduced for the benefit of various professions. Every professional people follow their own culture and mathematical ideas. Carpenters use one type of measure for woodwork; jewellers have their methods to measure the quantity and size of gold and silver; leatherworkers, Brahmins, porters, potters, dockers, etc., and all ethnic and racial group have their types of mathematics in their occupational fields (Devkota, 2013). Similarly, many indigenous people in our society prepare artistic statues, and carve doors and windows, *Gundri* weaving, *Ghum* weaving, *Doko*, and *Dalo* weaving have their mathematics, which is passed on from generation to generation in society. Our mathematics course is developed based on Western mathematics rather than our cultural mathematics; therefore, it is somehow difficult for students to understand. By incorporating multicultural mathematical ideas into our curriculum, students can benefit from their problem-solving skills and creativity.

Mathematics teachers experienced different types of problems in the classrooms due to cultural diversities such as local ritual festivals, and local *jatras*, including traditional practices.

> *…… of course, multiculturism is our nation's identity. Due to our multicultural practice, I have experienced some difficulties in teaching mathematics. We have many local jatras, festivals…. and cross*-*cultural as well as traditional cultural practices in different ethnicities and races. Particular races of students do not come to schools during their local festivals and ritual ceremonies; therefore, they miss the classes and students cannot cover mathematics by self-learning. In the Newari community, they participate in various jatras, local festivals, and*

traditions such as wood apple marriage (Bel vivaha), cave keeping (Gufa rakhne); selecting Kumari as a living goodness. In the Brahmin/Kshetri community, they do not send their daughters to school when they first suffer from menstrual cycles. Funeral functions in different societies also hamper the children's studies. In Muslim communities, school-children observe a month-long fast during Ramadan and perform poorly in their studies. These are only a few examples that I know and experienced but there are others too. I cannot repeat the entire chapters missed by many students due to the pressure of course completion.

Whoever the mathematics teachers, educators, and head-teacher talked to me strongly accepted our nation’s multicultural practice. Mathematics educators and head-teachers advocated multiculturism as our identity, opportunity, and beauty of the classroom, as well as a society but few mathematics teachers, talked about the challenges faced by them in the classroom discourse in mathematics as well. As diverse local festivals and traditions are celebrated in a diverse society, the children of this society are absent from the classroom for many days and they do not get to participate in classroom activities and even miss the opportunity of field trips, and fieldwork which are not regularly scheduled. Due to prolonged absences from the classroom and uneven participation in classroom discourse, students fall behind in learning and become anxious if they cannot return to learning.

A higher percentage presence of some castes and languages dominates the low percentage presence of castes and languages. Multicultural equity and respect are talked about verbally although they are unequal practically. Nepalese classrooms are more or less dominated by the language of Brahmins and Kshetris and so do the festivals. Holidays are given nationwide on festivals like *Dashain*, and *Tihar* (festivals of Brahmins and Kshetris) while only students of related castes are given leave on festivals like *Lhosar, Chhat, Ubhouli, Udhauli, Eid,* etc. This type of cultural dominance indirectly makes particular races of students weak in mathematics. Various cultural festivals can affect our mathematics teaching and learning. Due to local festivals, the students become absent for many days. This has (an) in/direct impact on the academic performance of students in mathematics. Students become technically weak in mathematics. We have unique cultural practices in some races of people such as the Newari community celebrating *bel vivaha*[30], *gufa rakhne*[31], *Kumari jatra* in Newari Culture, and other different *jatras,* and children of this community remain absent for several days during these local rituals. In many cultural and social groups, early marriage is another issue that affects school performance and interest in learning mathematics. Teachers believe that Nepal has cultural inequality and this unequal cultural practice influences challenges in mathematics teaching and learning.

Embedded culture and traditions can indeed play a role in shaping learning experiences, but certain practices or beliefs within a culture may have unintended consequences or limitations in an educational context (Camppella et al., 2013). The examples you mentioned, such as "Gufa rakhne" (keeping girls in seclusion before or during menstruation), not sending girls to school during their first menstruation cycle, funeral functions, and the concept of "kumari" (the living goddess) can indeed create challenges in the classroom, especially when it comes to the teaching and learning of subjects like mathematics. Gufa rakhne and not sending girls to school during their first menstruation cycle practices, prevalent in some cultures, can result in girls missing out on regular education during a crucial stage of their development. The

[30] In Newari culture, girls marry with wood apple in the age of 7 or 9 years before starting menstrual cycle.

[31] In Newari culture, girls at the age before starting menstrual cycle are kept in a dark room up to 12 days. In the 12th day, they are carried out from the dark room and allowed to see the sun directly.

absence from school during this time can disrupt their learning continuity and impact their performance in subjects like mathematics. This can create a gap in their knowledge and skills, potentially affecting their overall academic progress.

Funerals and mourning rituals are important cultural practices for many communities. However, if these events lead to prolonged absences from school or significant disruption to the learning environment, it can negatively impact students' educational progress, including their understanding and engagement in mathematics. The tradition of *Kumari*, where a prepubescent girl is worshiped as a living goddess, can also have implications for education. If a girl is selected as a *Kumari*, she is required to live in seclusion, often resulting in a prolonged absence from school. This absence can hinder her learning, including the understanding and application of mathematics concepts. Similarly, in Muslim communities, the observance of a month-long fast during Ramadan can have implications for students' performance in their studies. Fasting, combined with changes in sleep patterns and daily routines, may lead to decreased energy levels and concentration, which can affect academic performance, including in subjects like mathematics.

In these cases, it is essential to strike a balance between preserving cultural practices and ensuring access to quality education for all students. Education systems and communities need to work together to find solutions that respect cultural traditions while promoting inclusive and equitable learning environments. This may involve engaging with communities, raising awareness about the importance of education, and finding ways to adapt cultural practices to minimize disruption to students' learning journeys.

In the case of multicultural classrooms, Olstad, Foster, and Wyman (1983) claimed that teachers who have not received a multicultural education cannot cope with the challenges of a multicultural society well, and therefore have low expectations for minority children. Therefore, teaching and learning is difficult for culturally minority groups of students. The cultural diversity of a country should be an excellent way to practice the diversity of knowledge and experience, but due to the cultural identity of the students, is seen as a problem in Nepal’s education system, especially in mathematics classes (Panthi & Belbase, 2017). It is said that the country’s cultural diversity is an excellent opportunity for the practical application of various knowledge and experiences, but due to the student's cultural identity, it is regarded as an issue in Nepal’s education system, especially in technical subjects such as mathematics and science classes. Therefore, the mathematical education system has several seen and unseen issues because the cultural identity of students coming from different ethnic and caste-based communities has not been addressed adequately in the curriculum, teaching and learning, and assessment system (Davis, Phyak, & Bui, 2012). Similarly, Subedi (2010) agreed that multicultural issues in the current context are critical in most cases. These issues have been recognized as global issues of social, cultural, and political nature, but they are inevitable in education and are related to personal and social identity in schools and classrooms.

Teaching from Mathematical Artefacts and Teaching Materials

यथा शिखा मयूराणां, नागानां मणयो यथा ।

तद्वद् बेदांगशास्त्राणाम् गणितं मुध्नि संस्थितम् ।।

"Like the crest of the peacock,

Like the gem on the head of a snake,

So is mathematics at the head of all knowledge"

Maskey (2010)

Mathematics is viewed as a powerful as well as an abstract subject from the lens of many students, teachers, and educators. Mathematics is taken as a powerful subject because it is applicable in every field in everyday life and academic subjects. In my interview, a mathematics teacher said,

> *In everyday life, if a student goes to school, s/he estimates the distance between home and school and then manages the time to reach school; a housewife estimates the amount of rice, water, and time while cooking rice; estimates the amount of oil, salt, spices while making curry; our calendar is based on mathematics, horoscope, Jyotish Vidhya*[32]*, Cheena*[33]*, birth ceremony, solar eclipse, lunar eclipse and many more are un/knowingly based on mathematical measurements and calculations. If we try to understand these simple life-related issues in our everyday lives, mathematics becomes easy. Um…., I think mathematics is the backbone of every subject in academic teaching…….*

In my understanding of the above information, mathematics is encrypted everywhere in our everyday life but it needs to be viewed through the lens of mathematics. The simple and existing practices of our kitchen work, astrological functions, and walking all contain mathematical measurements, estimations, and assumptions. Mathematics is also applicable in statistics, physics, chemistry, biology, social studies, accountancy, computer technology, etc., therefore, it has been a top of knowledge of all knowledge as mentioned by Maskey (2010). Mathematics is everywhere if one views it from the mathematical lens. It is embedded in every cultural function of every caste, religion, and nation encrypted in natural and artificial artefacts.

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[32] Astrological knowledge.

[33] A *cheena* is a document that records the astronomical and geographical location along with the country and time of birth of a person.

Another teacher also advocated the mathematical artefact and teaching materials in my interview,

> *There are a lot of mathematical activities in our homes but they are still not included in our curriculum. The mathematical ideas contained in the cultural relics of the temples, mosque, church, stupa, stone, and wood carvings, Thanka paintings, Theki and Madani, Doko and Dalo, Nanglo and Chalno, Madal, Damphoo, Sahanai, statues, Rangoli made in Tihar, etc. can be utilized as cultural artefacts as well as teaching materials in school mathematics teaching and learning.*

From the above information, I came to know that mathematical artefacts are very simple, familiar, cultural, and meaningful objects through which abstract mathematical logic is carried into visionary models. Our everyday experiences of working with *Thanka* paintings, *Theki* and *Madani*, *Doko* and *Dalo, Nanglo* and *Chalno, Madal, Damphoo, Sahanai*, statues, and *Rangoli* made in *Tihar* also encrypt mathematical ideas and can be used as the mathematical teaching ideas and models but teachers claim that they are not incorporated in our mathematics curriculum. Existing mathematical ideas encrypted in cultural artefacts need to be connected in our classroom discourse of mathematics to make mathematics teaching interesting, meaningful, and permanent. Artefacts can be seen as a mapping that transforms abstract ideas into concrete, powerful, and meaningful images that evolve with different objectives in different social and cultural contexts. It helps to understand abstract ideas by mapping them into powerful and meaningful images created in fundamentally different environments (Pradhan, 2018). Cultural artefacts are anything created by the culture of a specific group of people, which provide information about the culture of its creator and users.

Gueudet and Trouche (2009) extended the definition of artefacts by introducing the terminology "resources" to cover any artefacts with potential. With this in mind, Bonotto (2007) believes that the widespread use of cultural products makes school mathematics more meaningful. Different types of cultural artefacts reflect the cultural identity of different groups of people such as clothes, houses, temples, paintings, patterns, etc. For classroom discourse, the artefacts displayed in the mathematics class are specific materials that children often encounter in real life. These specific materials can be useful tools for transferring from one domain of knowledge to another.

A head-teacher raised the voice of practical teaching through the existing mathematical models scattered in our everyday practice and cultural heritage.

> *Our mathematics teaching style is a bit old, a little boring, bookish, and imported. You see, there are so many arts and cultures, they are all valuable resources for mathematics. Why does our mathematics course teach about pyramids but not about temples? Our culture is closer to the temple than the pyramids. When teaching mathematics in our classroom, parallel lines, squares, rectangles, cones, triangles, and quadrilaterals are not only visible but also shown in the pictures drawn by the teacher on the board. These things have to be shown on the roof of our temples, in Gajur (the pinnacle of temples), in the Dhiki and the Janto, in the Halo and the Juwa, and the corners of our homes. And then our own identity is reflected in the teaching of mathematics.*

Based on the above conversation I had with the head-teacher, I can articulate that our mathematics teaching style is somehow traditional, rote-learning, and bookish rather than explorative in our everyday functions and cultural artefacts. The valuable sources of mathematics are encrypted in our temples, statues, *Dhiki* and the *Janto*, in the *Halo* and the *Juwa*, and in corners of our homes. The head-teacher claimed that pyramids and temples are quite similar and both are mathematical artefacts but we incorporated the study of the pyramid in our mathematics curriculum but not the temple although the temple reflects our cultures and they are visible concretely in our society. The concept of a pyramid is composed of a square and four triangles, therefore, it is the concept of triangles and quadrilaterals. Similarly, a temple is composed of quadrilaterals and triangles and it also provides a similar concept to pyramids. That's why mathematics teachers prefer the concept of the temple rather than the concept of the pyramid because temples are visible everywhere in our society.

Orchestrating students with visionary models encourages students to participate in and use a variety of materials, and stimulates their ability to associate artefacts with mathematics problem-solving. This innovative method is liberating because it opens up a different perspective and produces interesting perspectives for the transformation of the pedagogy of mathematics in the students' classrooms (Kortjass, 2019). One of the meanings of culture can be described as how members of a cultural group explain their experience through their language, symbols, values, norms, social practices, and the use of material artefacts (Acharya et al., 2021; Banks, 2016). Although the acquisition of mathematical knowledge from artefacts has been widely recognized, it is also important to incorporate it into the mathematics curriculum.

The role of artefacts in mathematics learning is very important. Learning artefacts specifically refer to objects designed by students to display knowledge (Kafai, 2006). In addition to physical objects, there are also virtual ones, including tools from information and communication technologies; different artefacts support different representation forms and are useful for cognitive development providing a great impact on mathematics learning (Bartolini Bussi & Mariotti, 2008). The educational standards of mathematics teaching also emphasize the transmission of different representation modes, because they enable students to exchange mathematical ideas and understand, and support the modeling and interpretation of mathematical phenomena (NCTM, 2000). Kress (2010) claims that fashion is a social and culturally defined resource that gives meaning. Music, gestures, speech, movies, soundtracks, and 3D objects are examples of modes used in presentations and communications. Modes provide different ways to give meaning. In some communication situations, these different potentials have a fundamental impact on the choice of type. Therefore, the ability to use different expressions in mathematics courses is the core, which helps to develop skills at all levels of the school. The mathematics pedagogy in the classroom also includes several symbolic patterns, language, mathematical expressions, and visual diagrams, as well as the gestures and movements of classroom participants and the meaning of structures (Schleppegrell, 2007). To understand mathematical symbols, in addition to discussion and conversation, speaking, and interpreting, learning mathematics also requires skills such as listening, questions, recognition, and testing (Ontario Ministry of Education, 2006). Therefore, mathematical artefacts can greatly benefit students and teachers in the classroom discourse to visualize abstract mathematical concepts and ideas.

Exploring the Hidden Knowledge in Mathematics Teaching

Mathematics is hidden everywhere and the beauty of mathematics is hidden in harmony, structure, numbers and forms, and symmetry. Mathematics is not only with numbers but it is also hidden in patterns, clothing, architectures, equations and proportions, landscapes, species of plants and animals including humans, in fact, almost everywhere in nature (Remiszewski, Pregowska, & Osial, 2021). In the context of Nepalese classrooms, only textbooks are taken as the sources of mathematics and the school children are rarely suggested to explore mathematics in their everyday life such as in calendars, kitchens, living rooms, roads, gardens, and classrooms. In the context of hidden mathematics, a mathematics teacher said,

> *If you search, mathematics is everywhere. If you do not search, you will not find it anywhere. Now our students see mathematics only in the mathematics textbooks they study because they are not made to feel that mathematics is everywhere. Mathematics is everywhere, in the worship of Gods and Goddesses, in our culture, in our homes, in our daily life, in our games, and in our astrology. If these things are taught to students from an early age, they will have a good grasp of mathematics and will never lag behind in mathematics learning.*

In my interview, a mathematics teacher claimed that mathematics is found everywhere if one views it from a mathematical point of view, otherwise, it cannot be found anywhere. In the context of Nepal, mathematics is taught to students what is given in the textbooks of mathematics but real and applied mathematics is found everywhere in our daily life. Mathematics is hidden everywhere – our calendar is based on mathematics; our ritual chanting is also in the mathematical rhymes; mathematics is embedded in every human culture; astrological activities are also based on mathematics. Our games such as *Baghchal*, Chess, *Nagpas*, *Ludo*, and Carom board… are also based on mathematical measurements or counting. If students are taught to explore the hidden mathematics in our daily lives and our every function, students will make the mathematical concepts in their daily works, and they will try to connect bookish mathematics in their socio-cultural activities and will never lag behind mathematics learning.

Mathematical thoughts and thinking are embedded in every ecological activity of a group of people; however, their mathematical thoughts in their daily work are still largely hidden. Mathematical anthropology uses mathematical models to describe the material and cognitive models of specific groups of people in history, ethnography, and material culture studies (Eglash, 2001). With this in mind, Rosa and Orey (2016) believe that mathematical modeling is a methodological tool that can be used in ethnic mathematical procedures. A positive path requires a broader view of the real mathematics practice and problems in the student's community (D'Ambrosio, 1998; Zaslavsky, 1996) such as the mathematical connections from the textiles, sand paintings, Thanka paintings, murals, ceramics, artworks, and handicrafts. Mathematical ideas implemented in a student's environment can be permanent imprints and mindsets throughout life.

The psychological background can be used as a cultural metaphor for teaching and learning school mathematics. Informal and hidden mathematical ideas and knowledge practiced and used in daily activities are the source of understanding abstract mathematical ideas. A cultural group of students can better understand school mathematics. Every society has different cultures and traditions concerning mathematical activities which are still hidden and unknown from the incorporation of the mathematics curriculum. The meaning and reasons for artistic and cultural artefacts related to mathematical concepts, ideas, and knowledge are almost unknown; although for a long time, different groups of people have been involved. People have hidden knowledge of mathematics in their daily work. They do ordinary things, but they have advanced mathematical concepts related to ethnic mathematics. The tools in the mathematics class can not only help students learn mathematical concepts but also help students learn cultural elements. Cultural relics related to mathematical thoughts are considered cultural metaphors for teaching and learning abstract concepts of mathematics at the high school level (Rosa & Orey, 2016). The student's ecological environment can be used as a cultural medium for school mathematics courses.

Informal mathematical ideas and knowledge practiced and used in daily activities are the starting point for understanding abstract mathematical ideas. The cultural connection of mathematics teaching provides a better understanding of school mathematics. Sociocultural capital (Bourdieu, 1973) focuses on different embodied cultures are the capital of their society on which different pieces of knowledge including hidden mathematical knowledge can enrich the classroom discourse if properly utilized.

ICT-Based Mathematics Teaching

Mathematics provides us with inductive and deductive knowledge, enriches our imagination and way of thinking, and even enables us to succeed in life. The material progress of the modern world is what the mathematicians contributed for improvement (Sarmah, Das, & Kashyap, 2020). Almost every part of our life is related to mathematics. Mathematical and scientific knowledge has played an important role in the development of modern technology tools, materials, methods, and energy to make our lives and work easier by improving the quality of life by reducing time, distance, and human influence.

Information and communication technology (ICT) is an indispensable tool in the modern education system, so its correct operation is essential to improve the teaching process. In my conversation, a mathematics teacher supported that the use of ICT is essential to promote the classroom discourse in mathematics.

> *…. of course, ICT is an essential part of classroom activities. Today's teachers cannot deny the application of ICT tools and software in classroom pedagogy.*

> *The use of ICT enhances the knowledge of students by making abstract mathematical concepts visible. Through the visual effect of images, graphs, animated figures, two- and three-dimensional images, and videos of classroom pedagogy including simple use of scientific calculators and mobile phones, students can build up the basic mathematical concepts to complex imaginary calculations. In my experience, it has been easy to teach mathematical concepts in each chapter of geometry, vectors, coordinate geometry, statistics, and arithmetic.*

In this conversation, the teacher easily assured the benefit of ICT application in the classroom pedagogy of mathematics. Mathematics teachers experienced easiness in teaching different types of concepts to their students through the use of ICT. The use of ICT is seen as the application of simple and scientific calculators to solve complex problems in a simpler and faster way. Students can use ICT to perform calculations, draw diagrams, and help to solve problems. The most obvious example of using ICT in this way is when students use calculators or something similar to perform more complex calculations. Algebraic systems or graphing calculators can be used to solve problems through testing and improvement or restoration methods. Mathematics students can use graphing calculators or plotters to solve equations graphically using alternative numbers. Students can use the extensive statistical functions of the graphing calculator to seamlessly analyze the collected information. Generating images in the dynamic geometry package can help students understand, solve, and test geometric problems. Students use ICT as a tool to discover things, solve problems, or understand what is happening, and often helps them develop skills in the use and application of mathematics. An effective tool, but students need to have the necessary technical skills to use these options constructively and effectively (Das, 2019).

Zakaria and Khalid (2016) found that the benefits of using ICT in mathematics classes are to stimulate students' interest in mathematics classes; improve student performance; promote lifelong learning; promote positive interactions and support constructivist learning. However, mathematics teachers face many restrictions when using ICT in the education process. The identified limitations include teachers’ ignorance of technology; few opportunities for ICT education and training; and limited technical support.

The head-teachers also emphasized the use and benefit of ICT-integrated education in the classroom as well as the students' and teachers' personal use.

> *To be clear, the present age is the age of science and technology. Thus, teachers and students can no longer stay away from the use of science and technology. Now, even if teachers are weak in ICT, they need to learn and teach their students. As a head-teacher, I am always ready to support the teachers as well as students in the field of ICT innovations. Adequate space, money, manpower, and morale are required to provide science and technology in schools. The young teachers seem to be proficient in the use of ICT but the old teachers are not so interested in technology. They do not want to learn ICT and do not try to teach students how to use it. In this situation, it is difficult to find an alternative for such teachers.*

I found that the head-teachers of the schools are also aware of the use of ICT in the classroom pedagogy in different subjects including mathematics teaching. They claimed that young teachers are capable of using ICT in the classroom but the old ones are neither well-trained nor interested in the field of ICT, which is creating a bit problem in schools as well. The head-teachers have managed the space, time, money, manpower, and strength for the application of new technologies that emerged in the field of the education system. They advocated that none of the teachers and students will stay behind the ICT in the age of growing science and technology although there are a few problems in the current situation.

Although planning and preparation are essential to the successful integration of technology into the mathematics curriculum, the academic excellence of ICT should be promoted in schools. Effective learning and retention of learned knowledge are the results of adequate infrastructure and a supportive atmosphere. A few teachers still do not trust the use of technology and need additional training. Schools should send their mathematics teachers to participate in seminars and workshops to update their knowledge. Teachers must possess ICT skills and should always be familiar with the latest technologies that have a profound impact on student learning (Sarmah, Das, & Kashyap, 2020). Teachers are the pillars to build a nation and they reveal the hidden potential of every child. Just like in other countries in the world, Nepal's efforts to provide every child with high-quality education are self-evident. Things depend to a large extent on well-trained teachers and quality education and well-trained teachers complement each other (Dixit, 2010). The ability of ICT to display text, images, sound, graphics, animation, and video provides an excellent opportunity for teachers to create interactive and engaging learning experiences, however, many teachers lack the skills required to use ICT effectively in the classroom (Baya'a & Daher, 2013). New educational technologies provide mathematics teachers with advanced and easy-to-use tools that can help students gain a deeper understanding of the related topics in mathematics.

In addition, these technologies enable teachers to work with students, while students are more immersed in their learning (Duhaney, 2000). The potential of technical tools makes the educational situation possible because they promote the active role and independence of students, enabling them to observe the research of scientific phenomena in different manifestations, and thereby gain a deeper understanding of the subjects and qualities mastered by teachers (Baya'a & Daher, 2013). Therefore, the available evidence is supportive and positive toward the direction of the application of ICT in the field of mathematics education.

The mathematics educators also provided supportive feedback on the appropriate use of ICT in the classroom pedagogy of mathematics in multicultural classrooms.

> *With the help of computer technology, it is easy to teach in a multicultural classroom, because students can easily understand the background, class culture, and socioeconomic status of different festivals of different castes, languages , and religions. There are uncountable websites full of knowledge of different subjects that we teach at the school level. These educational materials come in many forms, from simple to complex, and are provided in the form of text, sound, animation, graphics, and equations, making it easier for students to understand different cognitive levels in a multicultural environment. These materials can contain ideas from people of different races from all over the world, and incorporate cultures. Students and teachers can learn about the mathematics teaching methods in China, the United States, France, the United Kingdom, and other countries, by sitting in the corner of the classroom. Students and teachers can also compare and apply best practices in our classrooms.*

The above information reveals that the use of ICT in the classroom discourse of mathematics can integrate multiculturism because the teaching contexts, style, methods, ascent, etc. are created by people of various cultures, societies, cognition, religions, languages, etc. It makes it easy to understand the subject matters of mathematics when ICT is integrated into the classroom pedagogy because the educational materials come in many forms, from simple to complex, and are provided in the form of text, sound, animation, graphics, and equations, making it easier for students to understand different cognitive levels in a multicultural environment. Students and teachers are both benefitted from the application of ICT in classroom teaching, students will simply understand the background, class culture, and socioeconomic standing of various festivals of different castes, languages , and religions. When integrated ICT education works well, students who cannot attend classes normally will not miss mathematics classes, just as every student can master every concept at his own pace (Bhattarai, 2019). Using ICT in mathematics classes can improve learning efficiency and improve students' ability to understand basic concepts, but there are many obstacles in using ICT in the classroom (Keong, Horani, & Daniel, 2003). Jackson (2017) claims that the integration of ICT by mathematics teachers has been shown to have a significant impact on student performance. The teacher's role in deciding when, how, and where to use ICT will determine whether their use helps students learn mathematics. According to Goos and Bennison (2008) and Okumuş et al. (2016), ICT integration is manifested in three paradigms: teacher-technology interaction (micro model), teacher, the interaction between technology and environment (macro-model), the interaction between teacher and technology, teacher's beliefs, ability to improve ICT capabilities and their environment (comprehensive model).

Mathematics teachers are particularly interested in using ICT in mathematics classes as the use of ICT in mathematics are calculators, charts, computer graphics, special software, spreadsheets, and databases (Becta, 2003). Students are taught to work in collaborative groups or use the process of computer application problem-solving to solve problems, and then ICT participates in formulating solutions. Using ICT as a tool, students spend productive time developing strategies to solve complex problems and gain insights into different mathematics topics.

Using Culturally Relevant Pedagogy in Mathematics Classroom

Nepal is a multicultural, multi-ethnic, and multilingual country with different languages, genders, castes, sociocultural backgrounds, and religious beliefs. Mathematics classrooms form a mini-society of students coming from the same society and still adding different cognitive levels. Teaching such diverse categories of students in the same class is not an easy task for mathematics teachers. Therefore, one of the strategies to educate to culturally diverse students is applying culturally relevant mathematics pedagogy in the classroom discourse. By understanding the student's culture, language, interests, and traditions, teachers create meaningful learning experiences in the classroom where students need to connect to content and deepen their understanding of math (Phuyal & Budhathoki, 2022). Creating applicable instructions that are comparable to the student's experience in reaching the learner can be a valuable tool. Students can be intrigued by the understanding that mathematics is around us. To make students' learning experiences more relevant and effective, it is essential to take advantage of students' cultural knowledge, previous experiences, contextual patterns, and ethnically diverse performance styles (Phuyal & Budhathoki, 2022). Applying the mathematical skills they have learned in real-world situations is a great way to help students combine different cultural experiences and get excited about mathematics. For teachers to be culturally sensitive, they must spend time studying culturally and linguistically diverse students.

When planning mathematics lessons, teachers need to be able to improve their cultural response by connecting students to life and experiences both inside and outside the classroom. In similar contexts, a mathematics teacher Raj expressed his teaching experience in the following way.

> *The students in our classroom give us insights into our society, so I am always aware of what I must teach in a culturally diverse group of students, adding the religious and cultural concepts of society. Our daily activities, such as planting flowers in the garden, have mathematical patterns that provide the concept of rows and columns, which are useful for squares, square roots, and algebraic expressions. The geometric concepts of parallel lines, triangles, circles, semicircles, squares, and rectangles are encoded in kitchen, door, window, and furniture tools. Mathematical models, prints, engraved figures in temples, jewellery and clothing worn at festivals and celebrations, and figures and food made at festivals may contain mathematical concepts. Complementing these concepts with mathematics pedagogy makes mathematics lessons vibrant, contextual, and culturally relevant.*

From what I received from Raj, it was easy to understand that our classrooms are a direct reflection of our society, as our students come from the same society. Our society is a complex mix of different castes, religions, sociocultural structures, and language variations, and students add cognitive level variations. Mathematics teachers understand the complexity of society and seek to incorporate sociocultural, professional, and historical structures into mathematical discourse with the help of models, concrete materials, and examples. This allows students to contextualize mathematics and understand its relevance. The teachers gave examples of the mathematical concepts engraved in every design of temples, furniture, kitchens, costumes, ornaments, and even food prepared for various festivals. It would be easy if students could get a glimpse of these living experiences, activities, and exercises that could be related to the pedagogy of mathematics.

Mathematical modelling and culturally relevant pedagogy are both educational approaches that utilize knowledge of the student's daily situation and in the study of mathematical education, it is appropriate to explore more alternative ways to incorporate it into classroom discourse. Students need to make interpretive use of culture as a living experience. Mathematical knowledge is a perspective derived from a practical approach that can reveal practical knowledge related to the theory and daily use of mathematical functions and supports socially conscious reflections (Acharya, 2012; Anhalt et al., 2018). Applying culturally relevant teaching methods to the school curriculum is good management of students' intellectual, social, and emotional thinking using their own cultural contexts to express their knowledge, skills, and attitudes (Rosa & Orey, 2020). Culturally relevant pedagogy provides students with the opportunity to maintain their identity while advancing academically. In the context of culture-related mathematics education, teachers and students find in the classroom the same things they have seen, experienced, and practiced in their daily lives in the real world, and such activity bridges the gap between life experiences and the school curriculum (Hunter et al., 2018; Mitchell, 2010).

A culturally relevant pedagogy approach is the ethno-mathematical activities that aim to make school mathematics relevant, and meaningful, and enhance the overall quality of the student's educational experience (Acharya, 2015; Pradhan, 2018). Culturally relevant pedagogy and the cultural aspects of learners are incorporated by applying theoretical approaches and cultural relationships with the curriculum (Rosa & Orey, 2020). Introducing and applying culturally relevant pedagogy in mathematics teaching is one of the aspects of teachers, school management, and curriculum developers to promote student-friendly classroom discourse.

Using Think, Pair, and Share Strategy

Think, pair, and share is a collaborative learning strategy in which students work together to solve problems and provide excellent answers through the debate of alternative options. This strategy teaches students the need to think individually about a given problem, answer questions, and share ideas with classmates. Conversations with classmates maximize participation, attract attention, and help students understand what they are doing. Think, pair, and share is a collaborative learning strategy that enables students to read mathematical concepts, understand, solve problems, brainstorm, and personally communicate and assist in answering questions. Students first think about a given problem and then exchange ideas in small groups. The final step is to share their thoughts with everyone in the classroom. It helps to focus and motivates students to understand the reading material. For mathematical problems with multiple-choice answers, students think among their classmates, pair up and share, and are finally able to create correct answers using multiple ideas. This strategy can also be used by students to decide how to solve mathematics problems.

In the application of the think, pair, and share strategy of classroom teaching, a curricula designer and mathematics books author expressed his views as follows.

> *Designing mathematics curricula and textbooks is not the brainchild of a single person like me. There are various bodies of many academics and all know that practical, activity-based, real-life experiences need to be integrated into the curriculum. The same is true when you consider that our mathematics syllabus and textbooks contain topics such as simple and compound interest, money exchange, household arithmetic, profit and loss, area and volume,*

ratios and proportions, etc. These topics contain the problems with which one is directly confronted with the daily activities of students and teachers. I believe that teachers need to be active, creative, and pre-planned to deliver activity-based, project-based, and practice-based instruction, applying think-pair-share pedagogies in the classroom discourse. Curricula and textbooks and teacher's guides are the right guidelines. Exploratory knowledge needs to be built and shared by teachers as they have direct contact with students.

From the above information, it is revealed that curricula designers and textbook authors were conscious of the integration of everyday activities, and life experiences of the real world in mathematics. Curricula designers and textbook authors claim mathematics is the brainchild of various academicians and consists of daily used mathematics such as simple and compound interest, money exchange, household arithmetic, profit and loss, area and volume, ratios, and proportions. The major role of classroom instruction is the teachers, who can design and deliver activity-based, project-based, and practice-based activities to conceptualize the real knowledge of mathematics.

In a similar context, Afthina, Mardiyana, and Pramudya (2017) state that the think-pair-share strategy can be used in mathematics when students solve verbal problems. Students can think of a specific word problem and the steps that can be used to solve it. Without problem-solving, students can share their problem-solving strategies with their peers. After the discussion, the students can solve the problem on their own and compare the answers with their peers. It is useful in mathematics for solving verbal problems, making equations, and establishing the relationship between variables as it allows for discussing their ideas before solving the problem (Bachtiar, 2014). Students can think openly with their peers and get feedback on how to solve a given problem. The think, pair, and share strategy is a collaborative learning technique that encourages individual participants and applies to all grades and class sizes (Rullu, 2020). Students think independently about the questions asked and develop their own ideas. This opportunity allows students to articulate their own ideas and reflect on the ideas of others. Pairs of students share ideas with large groups like the whole class (Werdiningsih, Budiyono, & Pratiwi, 2019). Students are often accustomed to supporting peers when presenting ideas in groups (Henny & Uyun, 2017). This teaching strategy is student-friendly, interesting, constructive, and co-constructive in making new knowledge from the full of brainstorming (Istiqomah & Agustito, 2020). Think-pair-share strategy in classroom discourse of mathematics can create an interesting and student-friendly learning environment in the classroom.

Using Inclusive Mathematics Pedagogy

Mathematics education in Nepal is diverse in terms of age, gender, race and ethnicity, religion, learning abilities, cognitive levels, and socio-economic background. Inclusive teaching helps students enhance their learning level by recognizing the needs of individual students. Individual support is necessary to provide inclusive education as every student has their own learning and understanding styles and levels. Enabling equitable learning in these diverse classrooms is not an easy task for teachers and schools. By understanding classroom conditions and the efforts of teachers, a quality mathematics education can be provided that includes all the characteristics of students at different levels (Bock, Siegemund, Nolte, & Ricken, 2019). Efforts toward access and fairness include developing a socially, emotionally, and academically safe environment for teaching and learning mathematics (Jorgensen, 2020). In this perspective, an educator expressed his view in the following way.

There are a variety of students in our classrooms. They have their own castes, languages, religions, cultures, customs, and social environments. In terms of learning, different learning abilities, learning styles, and learning levels of students are present in our classrooms. Some students may be physically and mentally weak, even mentally challenged. In such a situation, everyone should be given the same kind of education to make them adopt equally, on the other hand, by identifying their individual abilities correctly, they should also rhetorically give advanced mathematical education. To do this, teachers should emphasize on inclusive education. The nation needs to develop teachers who can understand and deal with the situation in our classrooms and reform teacher training courses and seminars.

In my interview, one of the educators told me that mathematics classes are full of diversity in terms of caste, language, religion, culture, customs, and social background. Furthermore, students have different learning abilities, learning styles, and cognitive levels. To create equity, equality, and social justice in the classroom, teachers have to play a dual role in providing equitable education and they also need to provide a special and personalized education that is individually tailored to students' learning abilities. To overcome the complexities of our classrooms, inclusive, as well as specialized, and individualized treatment-type education can be useful. Teacher preparation courses and regular teacher training are also useful and mandatory in providing student-friendly education in diverse classrooms.

Inclusive teaching aims to provide education to all types of students without discrimination. Various needs and differently-abled arising based on caste, gender, language, culture, geographical difference, poverty, etc. should be properly considered and students should be guaranteed the right to quality education in a fair multicultural educational environment (Basnet & Banskota, 2013). To provide universal and accessible education to all students, it is necessary to bring the oppressed and marginalized Dalits, and minority community students, who are deprived of facilities and suffering from social and cultural oppression into the mainstream of education. Attention should also be paid to children affected by conflict, trafficking, and superstition (Phuyal, et al., 2006; Shiwakoti, 2022). Analysis of material, marital status, and aspirations of groups of students outside the mainstream of society should be prioritized in the inclusion (Tara, 2014). There is a need to strengthen records of out-of-school children, emphasize local language, active participation of students in learning activities, and enrolment of children in schools. For teachers, knowledge of the local language, qualifications, positive attitude, love and respect for students, records of students' status and development trends, participation and coordination with community members, respect for other cultures, and a child-friendly learning environment should be ensured with the pre-service and in-service teachers' training. Students should be encouraged to study in friendly classrooms and motivated in learning mathematics (Shiwakoti, 2022; Wright, 2016).

The good management of clean and bright classrooms, proper placement of furniture, construction of learning corners, special attention to students with special needs, preparation of materials, use, and management of materials, student motivation, teacher's student-friendly discourse, support the weak students to enhance their learning level (Mullick, Ahmmed, & Sharma, 2014; Sharma, 2019). By following peers, collaborating with teachers, playing with peers, maintaining discipline, and actively participating in learning, students can easily improve their mathematical ability. Inclusive education is essentially aware of all groups (handicapped and disadvantaged) and categories (handicapped and emotionally disturbed) of students and treating them without discrimination based on gender, caste, and learning variabilities (Basnet & Banskota, 2013).

To provide equitable mathematics education in diverse classrooms, Knigge and Kollosche (2019), state that it is an environment where students can connect with one another safely and confidently with the inclusion of diversity. Inclusive and comprehensive mathematics education includes recognizing students' diversity and supporting the diverse learning needs of all students. Mathematics education has traditionally been viewed as gradual skill development and challenges, unlike other areas of the curriculum ((Maudslay, 2014; Scherer, 2019). Inclusive education is based on the notion of students' diversity and involves supporting diversity and the full participation of all. Inclusive mathematics education generally requires welcoming, valuing, and supporting the diverse learning needs of all students. Therefore, inclusive education includes recognition of special needs or learning variability associated with different categories such as gender, learning disabilities, ability, location, and cultural and linguistic diversity related to mathematics (Beutel, Tangen, & Carrington, 2018). Therefore, I also believe in the educator's view and scholarly reviews and conclude that inclusive education can improve the overall learning facilities and environments providing the necessary requirements for student-friendly classroom cultures.

Use of Flipped Pedagogy

In our practice, usually, first of all, teachers introduce mathematics concepts of any lesson then teach problem-solving methods and finally assign classwork or homework to students. Oppositely, in the flipped classroom, teachers initially provide sufficient reading materials, watch videos, solve problems, and explore related materials for students individually or in groups. The flipped classroom is a classroom initiative to understand the benefits of learning in this unique way. In the flipped classroom, students learn homework from textbooks and videos while practicing in the classroom. In flipped classrooms, students watch online lectures, participate in online discussions, conduct surveys at home, and explore classroom concepts under the guidance of a teacher. Flipped classrooms employ an enhanced learning model that requires each student to understand a topic fully before proceeding to the next topic. A mathematics teacher explained the concept of flipped pedagogy by stating the following.

> *We, teachers and students, are lucky in the twenty-first century. Modern technologies have made teaching-learning methods easier and placed on the tip of the fingers. I have created a Google classroom for each classroom and organized enough reading materials, watching materials, listening materials, games, puzzles, animated videos, and different activities chapter-wise. Students have access to these materials anytime and anywhere if they are online with mobile phones, laptops, desktops, tablets, etc. Generally, I am busy teaching the different concepts of mathematics in the classroom and correcting the exercise books of students. Before starting the new lesson, I suggest to all the students which lesson to teach the next day and what they have to do. I encourage them to go through the learning materials organized on Google Classroom. There are video links to lectures, animations, 2D and 3D images, notes, worked-out examples, and screenshots of problems from the textbook. Initially, most of the students ignored visiting online classes, but gradually most of the students used it. I have also felt easy to teach in the classroom because students come from learning basic concepts from home. As everything is becoming smarter, today's students are also smarter. They want*

to know and explore many things. They enjoy activity-based, project-based, and exploratory learning styles. We, as teachers, should provide them with enough learning materials that they can easily access to meet their needs whenever they want.

Through an interview with a mathematics teacher, I came to know that classroom teaching and learning activities alone are not enough to meet the needs of students. In addition to classroom activities, sufficient learning materials such as notes, videos, animated videos, lecture videos, games, puzzles, quizzes, etc. should be organized in the learning portals, social media, libraries, mathematics, and science labs where students have easy access to learn from them. With the provision of learning materials and motivation before the classroom activities, students come from learning from their homes. This type of pedagogy enhances the learning motive of students creating interest in them, which is termed as 'flipped pedagogy'. Mathematics educators believe that learning from flipped pedagogy is permanent as students learn at their own pace through audio videos, animations, puzzles, quizzes, and mathematical models. A mathematics teacher shared his experience of managing the online and offline learning materials from which students learned and it made it easy to explore the ideas of specific topics. Previously provided learning materials created learning interest in students, and motivated them to self-learning by being interested, interactive, and alternative choices in learning.

Flipped classrooms are ideal for mathematics lessons because parents cannot teach mathematics problems to their children at home. Mathematics teachers have a great role in teaching students because students can learn other subjects by studying with their own effort, but mathematics cannot be learned by studying at home alone, it has to be taught in a systematic way (Baranchuk, 2020). If students do not complete their homework, they will be late for the content delivered or learned. Therefore, teachers should provide them with enough online and offline materials in a simpler form such as explained lectures, audio-video materials, models, and alternative methods from which students can learn from their own effort and can do the provided home assignments (De Clercq, 2013). Some materials may be alternatively explained to understand examples in the book, but it gives students another opportunity to see the problem that is actually being solved. It can be more beneficial to students' learning if they first understand the content and then apply that understanding to problem-solving on higher-level classroom tasks (Lesage, Kay, & Tepylo, 2019). All students and teachers should be trained to successfully complete the task using a web-based homework model.

Flipped classrooms are receiving positive attention from teachers and students who have adopted this new learning style. However, textbooks can be too difficult for students to learn and learners miss the teacher's detailed explanations (Radu, 2019). The main effect of flipped classrooms is to use classroom time to engage students in meaningful activities with difficult content because easy content is already understood by students' own efforts.

Contrarily, students must learn homework lessons from textbooks and video lectures and complete problem-based or project-based activities before attending a class. Students are motivated to learn and complete their homework through web-based instruction, and the use of video lectures is beneficial to their achievement (Willis, 2017). However, students can choose how to learn the flipped classroom content using video lectures, textbooks, or both. The flipped classroom model of teaching allows teachers to spend more time with individual students and better understand the content. However, flipped classrooms give students more time to explore their understanding of the content in the classroom and increase the one-to-one guidelines from the teacher (Ölmefors & Scheffel, 2021). The hybrid model helps to better understand why it is important for teachers to continue to play a role in the classroom when they are providing online instruction. The flipped classroom model teaching has a positive impact on students, teachers, and parents. The flipped classroom model also provides an opportunity for students to work at home and seems to benefit all students because they can learn the lessons in advance (Willis, 2017). In addition, many students have a variety of learning abilities that require individual attention and classroom instruction to succeed.

Use of STEAM Pedagogy

STEAM education is an interdisciplinary approach that integrates concepts from different disciplines rather than teaching each subject individually. This learning approach emphasizes project-based learning and focuses on finding solutions to real-world problems. Students work as a team to integrate knowledge and concepts to solve problems. Architects combine various concepts such as science, technology, engineering, art, and mathematics to design complex, feasible, and practical buildings (Lamichhane, 2021). It is impossible to design a building without incorporating all the skills and knowledge from different disciplines. STEAM education provides opportunities for students to explore and discover their creative pursuits and plays an important role in capacity development (Kim, 2014). It is based on the idea that students can really do well in subjects they are interested in. Every child has a natural learning instinct, and the best way to inspire them is to introduce them to STEAM education early in life. If they are truly passionate about STEAM education, they can also pursue career paths in relevant fields (Kobayashi, 2018). STEAM education benefits students across the overall skills, in expanding their mathematics horizons and learning other disciplines, an educator said.

> *If some teachers see a science book in front of their students while they are teaching mathematics, the tradition of getting angry, taunting them, throwing the book, abusing them, and embarrassing them among their friends is still seen in our classrooms. But teaching in the 21st century is not only to make students excel in one subject, it should be aimed at them to be able to identify problems in real life and solve them, and create jobs in the future. Collaboration is not only among the students, teachers of different subjects should also be able to discuss and collaborate sufficiently with each other on what to teach today, how to teach, and what materials can be used to connect multiple disciplines. Now, a teacher should not think separately to improve specific subjects, they need to work collaboratively with project-based, practice-based, and field-based teaching integrating the concept of the various disciplines. Only if this can be done, the concept and knowledge of various subjects will be permanent, students can do well in all subjects and this knowledge will be useful in real life as well. Today's STEAM education is also the integration of fragmented knowledge into a variety of subjects, much like engineers integrate their knowledge of art, science, mathematics, architecture, and astrology to prepare a good map and a good house accordingly.*

From the conversation with the mathematics educator, I realized that the teachers try to make the students improve more in the subjects they teach and they want the students to score better marks in their relative subjects than others. Therefore, as mentioned by an educator, teachers do not think, it is good to study other subjects or do homework on other subjects while teaching one subject and scold them, making them a fear of punishment. If students ignore the subject being taught and do homework on other subjects, then they cannot learn well. If knowledge is given by integrating multiple disciplines, students will learn quickly and easily when they learn by connecting the concepts of one subject with another subject. Collaboration is not only among the students, but teachers of different subjects should also be able to discuss and collaborate sufficiently among them on what to teach today, what method is followed, and what materials can be utilized to connect multiple disciplines. The teachers should not think alone to improve specific subjects, they need to work collaboratively with project-based, practice-based, and field-based teaching integrating concepts of the various disciplines to make permanent learning. STEAM education connects fragmented knowledge and skills across disciplines and helps explore and solve real-world problems experienced in everyday life.

STEAM education emphasizes an integrated curriculum for using knowledge and skills in creative and imaginative ways. STEAM pedagogy helps teachers and students to combine skills across disciplines in science and mathematics (Han, 2013; Ryu, 2015). An important feature of STEAM education is the practice of the notion that schools are places of production or creation. It helps to replace traditional chalk-and-talk teaching methods with a series of carefully designed classes that allow students to explore, analyze, evaluate, and engage in the learning process. STEAM education provides students with certain theoretical, philosophical, academic, and practical knowledge, skills, attitudes, and habits that will be fruitful throughout their lives and professions (Culén & Gasparini, 2018). Simple materials such as pieces of wood, straws, paper cups, and other inexpensive materials can be used to motivate students towards design and art integrated with math and science. Students need to be prepared for future careers with mathematics, science, technology, engineering, and art skills (Kandel, 2018). When students build simple things like toy robots, hydraulic cranes, and electric cars, they can learn to incorporate the skills and concepts of battery, power, energy transformation, connection, polarities, and modelling with art (Colucci-Gray, Burnard, Gray & Cooke, 2019). By integrating different subjects into STEM education, students can be encouraged to practice learning concepts with more enthusiasm. In a similar context, Belbase (2019) claims that STEAM pedagogy improves four basic skills such as creativity, collaboration, critical thinking, and communication between classmates and teachers, which are an essential parts of future professionals.

Chapter Summary

In this chapter, I explored how to cultivate student-friendly mathematical discourse in the daily classroom pedagogy of mathematics teachers by using various experimental practices. Lively, short and sweet, easy to understand, more focused, student-centered, personable, interesting, and meaningful ways of presenting the classroom contents can greatly contribute to learners. I iteratively discussed with mathematics teachers, head-teachers, and mathematics educators about the innovation of mathematics pedagogy and the information revealed mainly ten thematic issues, if the teachers are very concerned about those issues, the classroom discourse of mathematics will step forward to address the multilevel cognition and multiculturism of the students in the interesting ways. The various thematic issues which were discussed to make the classroom discourse student-friendly were: collaboration and teamwork; a student-centered classroom; creating a fearless environment; engaging every student in mathematics discourse; allowing students to create their problems; suitable classroom discourse in mathematics; advocacy of the multicultural mathematical pedagogy; teaching from mathematical artefacts and teaching materials;

exploring the hidden knowledge in mathematics teaching, ICT based mathematics teaching; use of think pair and share strategy; use of flipped pedagogy; and use of STEAM pedagogy. I illustrated the collected information in a meaningful and understandable form linking it with the existing theories of my interest.

CHAPTER VII

CHALLENGES OF MATHEMATICS CLASSROOM DISCOURSE

There exist numerous challenges while performing pedagogical discourse in mathematics classrooms in Nepalese classrooms. Teachers, as well as students, are facing challenges due to the lack of experience in managing the classroom, cognitive differences of students, language variations, teachers' and students' misperceptions, the existence of cultural diversity in the classroom, and many more. This chapter aimed to disclose various challenges faced by both students and teachers in the orchestration of classroom discourse in mathematics.

The Challenge of Classroom Teaching with Bilingual Mode

Mathematics teachers have suffered from different problems while teaching in the classroom due to variations in language, students' cognitive levels, economic contexts, and socio-cultural diversity. To compete with the private schools, the community schools had adopted the English medium mathematics textbooks but most of the students did not fully understand the English language. Therefore, teachers had to teach in both English and Nepali. Teachers agreed that this activity had a good effect on students who could learn languages in addition to math, although the process was difficult. Students in community schools had different cognitive levels and a variety of learning abilities, so the same teaching style and the topic were overloaded for some students while it was not enough for others. Students in the class were absent frequently and at random, making it difficult for teachers to complete the course on time. Some students never completed their homework and teachers needed to know why homework had not been done. If they hadn't understood, teachers needed to revise the whole chapter. The teachers did not have enough time to check all the students' homework, teach in the classroom, manage the project work, make the lesson plan, and motivate the unmotivated students.

Raj shared his experience of difficulty in the classroom discourse with dual language as follows.

Dialogue 4: We are talking in Nepali and writing in English

BB: *Let’s talk about the mathematics class. Is it okay if I ask some questions?*

Raj*: Of course.*

BB*: I noticed that you, as well as the students, were talking in the Nepali language and writing in the English language during the classroom discourse. What do you say about this?*

Raj*: Yes, you are right. I think we have been following this train for 4 or 5 years. As the number of private schools increased in the locality, parents and students were attracted towards them. Then, we also followed English language textbooks in mathematics but our pedagogic activity is unchanged. As you know, there are students of different learning capacities in the same classroom and some of them are very weak in mathematics background. Not all the students in the classroom understand the English language fully; therefore, we are doing so.*

BB*: What are the challenges of teaching mathematics in such types of community schools?*

Raj*: One is that we just talked about, talking in the Nepali language and writing in the English language. It is okay for algebra teaching but students do not understand the English language fully. In the case of verbal problems, we first read aloud in the English language and then translate and communicate in Nepali twice or thrice, and then the only student gets the concept. We encounter students from different communities, cultures, languages, cognitive levels, and interests. To handle, such a* *multicultural and diverse classroom is challenging. We use multiple pedagogic activities so that almost all the students get into the concept of mathematics.*

As I talked with other mathematics teachers, some of them claimed that language does not make any difference in mathematics teaching-learning activities. But, some of them argued that due to the lingual variation at homes and schools, teachers and students are facing a few problems.

Mathematics does not exist in a linguistic vacuum. This means that when teaching mathematics to students, mathematics teachers should not only try to teach mathematics but recognize their dual role as mathematics and language teachers (Brown, Cady, & Taylor, 2009). Teachers need to be aware and sensitive to the problems of mathematical language acquisition and be creative and persistent in finding ways to support student learning. Planning for learning is easier if teachers are aware of common language difficulties in the classroom (Zohrabi, Torabi, & Baybourdiani, 2012). While language can be a barrier to participating in math, it also provides a solution. The key to success in mathematics is being able to own the language and concepts that make the language of mathematics different from ordinary language (Jourdain & Sharma, 2016). It is important to promote in a class by making connections between mathematical terms, teaching language and experiences, and using your mathematical language through the discussion. Dealing with multiple languages in the classroom is a challenge for teachers. Finding resources in the student's mother tongue and ensuring a student's mathematical understanding when there is a language barrier is difficult (Jourdain & Sharma, 2016). When teachers do not speak the language of all the students in the classroom, they have a hard time understanding student responses.

After, involving with the teacher's unauthentic and free talk, Nayantara Madam and I went to the small cabin in the office. With a cup of coffee, we had a very important conversation about the classroom teaching of mathematics.

Dialogue 5: We are Using Student-centered and students-friendly Pedagogy

BB: *How do you feel being a mathematics teacher?*

Nayantara: *I feel proud of myself as being the mathematics teacher of the community school. But this field has more challenges than opportunities. I encounter a variety of students according to social and economic status, religious and language background, diverse cognitive standards, and, cultural variations of students. It is very difficult to satisfy all these students. So, no matter how well you do it, it is not easy to get it.*

BB: *Well, Nayantara Mam, how long have you been in this profession, could you please tell me about your special experiences too?*

Nayantara: *Yes, probably [Laughing ….], I have been involved in this teaching profession for more than two decades. When I was appointed as a primary-level teacher, I had an opportunity to teach in grade three. Initially, I felt some difficulty in teaching but as time passed, I learned different pedagogies. Student motivation is an important responsibility of a teacher. As I taught in grade 3, I experienced that after a few minutes, students got diverted from writing and reading. To control this habit of students, I used to buy many colourful pieces of chalk. I asked students to do classroom assignments and if they finished quietly, I used giving them a piece of chalk and provided them with the opportunity to write their names on the blackboard with colourful pieces of chalk. From this activity, all the students got so motivated, that they used to finish their work at the right time throughout the year.*

BB: *What types of challenges do you face in the mathematics classroom?*

Nayantara: As a mathematics teacher, I have faced many challenges. I would like to talk about a few of them. Um… here, I meet different students with individual learning efficiency, diverse languages, religions, and cultures in the same classroom. As you know, our curriculum is rigid and monocultural. However, we are using multicultural pedagogic activities, student-centered, and student-friendly mathematics discourse practices, they are not enough to address individual support. Our parents are not qualified enough to support their homes. Now, we are focusing on "activity-based pedagogy", "immense use of teaching materials", and "teaching through ICT". We also have some house worker students. They do not get enough time to practice mathematics at home. Whatever student-friendly methodology is followed, practice is the epicenter of mathematics learning.

BB: *Do you think our mathematics course is multicultural?*

Nayantara: *I don't think so. But it has been changed now and then. Improvements seem to be continuing, but not enough.*

From the above information, I generated the following theme and interpreted it.

Emphasizing Written Discourse

In my classroom observation and interview with mathematics teachers, I found that every teacher emphasized written discourse. Written discourse in mathematics is the way that mathematical information is communicated through written language. This can include equations, proofs, definitions, theorems, and other types of mathematical statements. Writing in mathematics is often used to explain concepts, solve problems, and communicate ideas. The main difference between written discourse and note-taking is that written discourse is a more formal type of writing, whereas note-taking is more informal. Written discourse is usually more organized and structured, and it usually includes more detailed explanations and diagrams. Note-taking is more about jotting down ideas quickly, without necessarily logically organizing them.

Teachers first explained mathematical concepts with charts, formulae, teaching materials, use of ICT, and relevant examples linking with mathematical theories in the concerned topics. They asked students about the concept of built-in students. If some students did not understand properly, the teacher revised the entire activity in groups, with individual students, or with the whole class. Then, teachers focused on the practice of problems by using different problem-solving methods. They made students do on the board, explain among the students, present with charts, group works, group discussion, etc. In Nayantara's words "*Whatever, the student-friendly methodology is followed, practice is the epicenter of mathematics learning*". The written practice is the backbone of mathematics teaching. The teacher argued that it is necessary to give a clear concept of mathematics in the concerned topics and that written practice is most important. Whatever, the strong concept provides, if there is a lack of frequent written practice, students forget problem-solving techniques. It is said that practice makes a man perfect.

When I reached School A, to observe the class of mathematics teacher, she was absent on that day. Then, I entered the head-teacher's cabin. The head-teacher was in his cabin. As soon as he saw me, he asked me to take a seat. He asked me, "How is your research going on? Is there any problem?" I replied it was going well. I felt a good environment in that school. Every teacher was very helpful and supportive. I had come here to observe one class today but miss has been absent. The head-teacher said to me, if you don't mind and you have time, you can go to her class to engage the students. I was happy to be in class. Since I had already observed this class 2 times, I was not a new face to the students. I found that students were familiar with and fond of talking with me. I divided the entire class of students into four groups, namely Group 1, Group 2, Group 3, and Group 4 because I wanted to interact with them to understand their concepts of mathematics subjects and teaching methods.

Dialogue 6: Mathematics is so Boring

BB: *How do you find mathematics, is it interesting?*

Group 1: *Oh, no. It's not interesting. It is one of the hardest subjects.*

Group 2: *It depends on the topics. Some topics are easier but others are difficult.*

Group 3: Mathematics *is so boring.*

Group 4: *We should memorize so many formulas. How can it be interesting?*

BB: *Why do you think that mathematics is one of the hardest subjects?*

Group 1: *It is rarely used in our daily life. Some arithmetic is applicable but where is this algebra used?*

Group 2: *We give less priority to mathematics. It has sharp formulae and rules on every topic.*

Group 3: *Sir, you know what happens. We practice at home and school but if we fail to solve a problem in any chapter, we cannot proceed with others.*

Group 4: *It is not like Nepali, Social, and English learning. We cannot understand the technical language and technical terms used in the subject.*

BB: *Does your mathematics teacher teach you by using teaching materials?*

Group 1: *She does not use teaching materials every day. Sometimes she uses.*

Group 2: *Sometimes our teacher asks us to make teaching materials by ourselves.*

Group 3: *Our teacher and we collaboratively prepare teaching materials and models for the exhibition. It would be very fun at that time.*

Group 4: *Our teacher explains nicely in the classroom. Some of the students do not pay attention to learning and they do not understand. They also do not do their* *homework by themselves. They just copy from their friends to show teachers. Those students find mathematics a difficult subject.*

BB: What types of activities do you follow in the mathematics classroom?

Group 1: *The teacher introduces the chapter. She writes necessary formulae. She makes us rote learning of formulae. She teaches how to solve problems using formulae.*

Group 2: *We understand what our teacher teaches us and we follow our teacher.*

Group 3: *We do classwork and homework. We have also interactions with teachers and ourselves.*

Group 4: *We study in groups sometimes. We also go to the ICT lab and mathematics lab.*

From this group discussion, I came to know that some of the students take mathematics as a difficult subject. This is due to the less attention in the classroom during the classroom discourse. Those students who do not come to school regularly, do not do homework regularly, and, do not pay full attention during the teaching-learning activities felt hardness in mathematics. However, those students who are regular in the classroom do their classwork and homework regularly, fully pay attention to the teaching-learning activities take mathematics as a normal subject. According to students' claims, mathematics teachers also do not teach students by using teaching materials regularly. The mathematics teacher did not give special care to the students individually. From the above information, I generated the following theme and interpreted it.

Mathematics in the Eyes of Students

Most of the students found mathematics to be a less interesting subject. They considered mathematics to be one of the most difficult subjects. Mathematics was such a boring subject that the students had to memorize so many formulae. Students who viewed math as a difficult subject entered the class with less interest and did not even complete their homework on time. Some students found mathematics to be an easier subject because they got much more involved in classroom activities and even completed their homework. The students agreed that they gave mathematics less priority because of the difficulty in memorizing different formulas in each topic and the new rules for solving problems. Students practiced at home and school, but could not easily complete their homework without the help of a few experienced students and teachers. In most cases, some students simply copied their classmates' homework and presented it to their teacher without understanding the topic. The teaching activity was often a lecture method and, sometimes had participatory classroom teaching activities, with the teacher and students jointly making the teaching materials and models. Many students said that they did not understand mathematics the way they did in other subjects.

Algebra was seen as completely abstract with symbolic language and only one rule to finding the answer. Students see mathematics as a school subject that is used in a variety of contexts in everyday life, at work, for learning other subjects, and for future study. Students found mathematics as a form of exercise or mental activity that is used to develop intellectual and problem-solving skills. Students viewed mathematics as a group of numbers and rules for doing calculations. They also viewed mathematics as a language used to express the relationships between objects and quantities and to describe the physical world. Relationships between objects and quantities were reported more frequently. Students knew that mathematics was an art form and it allowed them to express their creativity. Some students had not been able to explore its use in their daily lives except for the limited applicability of arithmetic but not algebra. All the students in the conversation assured me that mathematics was a leading subject in school education and one who is perfect in it had great respect among them and teachers as well. From the above information, I generated the following theme and interpreted it.

Strategies for Addressing Students' Learning Difficulties

Teachers performed various actions based on their findings to diagnose students' difficulties in learning mathematics in the classroom. The classroom observations, answering the questions, classwork, and homework, participation in the classroom activities, and class tests were diagnosing activities in the classroom from the teachers' side. After knowing that the particular student was weak in some specific topic or entire subject, mathematics teachers used some innovative activities that supported the weak students. The main action of teachers was corrective in the form of re-learning and revising the related topics. Many teachers also performed exercises and practices to overcome students' learning difficulties. The change in teaching strategies and media that remove students' learning difficulties is a minor action taken by teachers (Wijaya et al., 2019). Individual care is necessary to overcome the students' mathematics difficulties in learning.

Teachers used a variety of methods to diagnose and overcome students' learning difficulties. There were three ways for teachers to diagnose learning difficulties in math, including tests, observations, and oral interviews with students. The ways to overcome them were to take corrective action, provide one-to-one mentoring, provide overtime for students who have difficulty learning mathematics and involve students in the learning. The method used was effective, as evidenced by changes in student understanding and improved student learning outcomes (Febriyanti, Mustadi, & Jerussalem, 2021). The teachers did not yet make an in-depth diagnosis of pupils' difficulties in learning mathematics. Teachers focus only on mathematics topics and non-math problems, rather than on student thinking processes. Teachers also did not differentiate between diagnostic, assessment, and predictive tests. As for the strategies used by teachers to diagnose student difficulties, the analysis of student responses to tests was predominant. In this regard, observation of the learning process of students during classroom activities was rarely done by teachers to diagnose students with learning disabilities (Attlah, 2003). The results of the diagnosis are mainly used as the basis for recovery and exercises and practices. The results implied that more support is needed for teachers to improve their skills, especially in diagnosing students' thinking difficulties when learning mathematics (Wijaya et al., 2019). Teachers do not have a better understanding of the local context, but understanding students' values can also develop meaningful perspectives on culturally appropriate and effective programs that are designed and implemented (Seah, Davis, & Carr, 2017).

In the context of Nepal, every mathematics teacher should feel that every student in the class could not understand the problem-solving method s/he was teaching in the classroom. Due to the presence of large numbers of students in the classroom, individual diagnosis and treatment were also not possible, and even teachers could not frequently check all students' homework. They applied the method of random checking of homework of some students. When found to be relatively weak in the classroom, teaching to be more focused on the activities of weaker students, during discussions, classwork, and homework. Most teachers gave weak students extra time and suggested learning with them in their free time as well. Some teachers provided extra classes to weak students with acceptance from school management, parents, and students at minimal cost, but coaching classes and extra classes were mandatory for students appearing for SEE (Secondary Education Examination). It was found that better care was provided to those students who were going to participate in the SEE and BLE (Basic Level Examination).

Classroom Vignette 10: Teaching of Profit and Loss

On the 5th of December 2019, I went to observe the classroom discourse in mathematics at School A. Mr. Sanjog was going to teach the topic of ‘profit and loss in class 8 section B. When we entered the class all the students stood up and greeted us and we also greeted them too. There were 61 students in this class, among which 27 were boys and the rest of the students were girls. There were 17 sets of desks and benches arranged in 3 rows. 3 or 4 students were sitting on one bench. With 3 students sitting on one bench, there was enough space for students to read and write, while 4 students sitting on one bench did not feel enough space for students to read and write. Sanjog showed me all the students and said, “*There are a few more students, so let's sit together*”. I sat on one of the benches having 3 students. The students spontaneously took out books, copies, and pens, and prepared to read .The teacher wrote the date and the chapter’s name on the whiteboard and the classroom discourse started as follows.

Teacher: *How many of you have a shop in your house? Please raise your hands.*

Five of the students raised their hands. The teacher called all 5 students (2 boys and 3 girls) in front of the classroom.

Teacher: *Do you know how profits and losses occur?*

S1: *There is profit when articles are sold at a higher price than they are bought, but there is a loss when articles are sold at less price than they are bought.*

S2: *That’s it, Sir.*

S3: *I do not know. I have never gone to our shop. My parents go to the shop.*

S4: *When we sell things at a higher price than the cost price then there is a profit otherwise there is a loss.*

Teacher: *Although your friends were correct, I want to add a few more things here.*

[Teacher wrote on the board.]

Cost Price: *The price for which an article is purchased is called the cost price. C. P. denotes it. Generally, all overhead expenses like labour charges, taxes, etc. are also included in the cost price.*

Selling Price: *The price at which an article is sold is called a selling price. S. P. denotes it.*

Profit: *When the selling price is higher than the cost price, then there will be profit or gain. P. denotes it. The difference between the selling price and the cost price is called profit.*

Thus, Profit (P) = S. P. – C. P.

Loss: *When the selling price is less than the cost price, then there will be a loss. L. denotes it. The difference between the cost price and the selling price is called profit.*

Thus, Loss (L) = C. P. – S. P.

The teacher sufficiently defined the terms used in the chapter. He asked a few students to recite what was written on the board. He also asked whether they (students) understood the terms that he used.

Teacher: *According to your colleagues' definition of profit and loss, can you write the relation between profit, cost price, and selling price.*

S5: *Yes sir, I can write.* [She wrote on the whiteboard].

Profit = selling price – cost price

Loss = cost price – selling price

The teacher thanked them and allowed them to sit in their place.

Teacher: *Your friends were right. Whatever they said about profit and loss, it was all right. He wrote what S1 said 'There is profit when articles are sold at more price than they are bought, but there is loss when articles are sold at less price than they are bought.' But here, we write Selling price = S. P., Cost price = C. P., Profit = P, and Loss = L as abbreviations.*

Now, according to your friends,

Profit (P) = selling price (S. P.) – cost price (C. P.)

On arranging, you bring cost price (C. P.) on the left-hand side and Profit (P) on the right-hand side. You will find as,

Cost price (C. P.) = Selling price (S. P.) - Profit (P)

Similarly,

Selling price (S. P.) = Cost price (C. P.) + Profit (P)

Now, again we have this relationship.

Loss (L) = Cost price (C.P.) – Selling price (S. P.)

Teacher: *Could you arrange it?*

Students were seen busy arranging the relation given above.

A boy: *sir, I finished.*

Teacher: *Okay, you come here on the front side with your notebook.*

The boy came in front of the class near the teacher.

Teacher: *You do on the whiteboard what you have done on your notebook.*

The boy looked at his notebook and copied on the whiteboard what he had done in his notebook.

Loss (L) = cost price (C.P.) – selling price (S. P.)

Selling price (S. P.) = cost price (C.P.) - Loss (L)

Cost price (C.P.) = Selling price (S. P.) + Loss (L)

Next boy: *I also finished.*

Teacher: *If you have finished, compare it with what was done on the whiteboard by your friend.*

A girl: *Sir, is it right what is done on the board?*

Teacher: *Yeah, it is right. Your friend is right. All of you check with this* [showing what was done on the whiteboard by one of the boys] *and if your work is different make corrections.*

Students: [They were silent and doing what their teacher said.]

Teacher: *We have a few more relations which I write on the board as a brief note. Copy this.* The teacher wrote on the board as given below.

Profit percent and loss percent are always calculated on the cost price. Profit on Rs. 100 is called profit percent and loss on Rs. 100 is called loss percent. Remember the following formulae for calculating the profit percent or loss percent.

(i) Profit percent = $\frac{Actual\ Profit}{C.\ P.} \times 100\% = \frac{S.\ P.-C.\ P.}{C.P.} \times 100\%$

(ii) Loss percent = $\frac{Actual\ Loss}{C.\ P.} \times 100\% = \frac{C.\ P.-S.\ P.}{C.P.} \times 100\%$

(iii) When the number of articles purchased and their unit cost are given, then the total cost price is calculated by the following formula.

C. P. = N × C, where N = the number of articles purchased, and C = unit price.

$C = \frac{C.P.}{N}$

(iv) Similarly, the total selling price is calculated by the following formula.

S. P. = N × S, where N = number of articles sold, S = unit selling price.

$S = \frac{S.P.}{N}$

(v) S. P. = $\frac{(100+Profit\ percent)\times Actual\ C.P.}{100}$, S. P. = $\frac{(100-Loss\ percent)\times Actual\ C.P.}{100}$

(vi) C. P. = $\frac{Actual\ S.P.\ \times 100}{(100+\ Profit\ Percent}$, C. P. = $\frac{Actual\ S.P.\ \times 100}{(100-Loss\ Percent}$

All the students copied what their teacher wrote on the board. The teacher advised the students to come the next day by memorizing the formula and the class ended.

In my observation, I found that there were more than enough students kept in the same classroom and students had a problem with reading and writing. They did not have enough space to carry on the academic activities in the classroom. The classroom was quite congested. The mathematics teacher loaded there with more formulae than necessary. Students have participated with their teachers except for a few. From the above information, I generated the following theme.

Formulae Dominated Mathematics Classes

Mathematics is a vast field. One person can't know everything there is too much to know in mathematics, even after a lifetime of study. And while it can be cumbersome, mathematics is also one of the most important fields of study. The formula is a fact or a rule written with mathematical symbols. It usually connects two or more quantities with an equal sign. When one knows the value of one quantity, s/he can find the value of the other by using the formula. A formula is a group of mathematical symbols and numbers that show how to process something. In brief, mathematical formulas provide two things: reusable frameworks and the ability to quantify veracity. Most of the equations that arise in real-world contexts cannot be solved. Although they can, it is often faster and easier to use a calculation method to find a numerical solution. The real power of equations is that they provide a very precise way of describing various characteristics of the world. Many students find mathematics difficult as they cannot remember all the mathematical formulas. Even if they remember, they are unaware of the use of these formulas appropriately. Remembering and memorizing the mathematical relations of symbolic language may be challenging to the students and if the students cannot do that, they suffer from mathematics anxiety.

In my observation, I found a few students were not taking an interest in the study. They were doing something else without paying attention to the classroom. I wanted to know why they were not paying attention in the classroom, therefore, I asked the teacher to arrange 15-20 minutes to talk with a few students. I went to the mathematics lab with 5 students whom I selected. My question to them was, why they didn't pay attention in math class? On my question, their reaction was as follows.

A boy:

> *I am a weak student in the classroom. I never liked mathematics. It is a subject that only clever and smart students can study properly and pass with good grades. Every student and teacher as well, knows that I am not a good student of mathematics. But I like social studies. I am good enough too. I felt mathematics was a difficult subject in each class and I passed on grace marks. Again, I don't think I will do anything in mathematics in the future. I like to be an artist. I am very good at drawing. I have won many prizes for my art.*

Next boy:

> *I neither like mathematics subjects nor mathematics teachers. It is one of the most difficult subjects for me. I tried my best, but I couldn't do well. Our mathematics teacher gives a lot of homework that only talented students can do. I just copied from talented students. If I ask questions in mathematics, most of the students laugh at me saying that I don't even know that much. Our*

> *mathematics teacher also focused on talented students rather than the weak ones like me. I stopped studying mathematics because it was so bad.*

A girl:

> *Mathematics subject has several complex formulae which are necessary to memorize. Without memorizing these dangerous formulae, there is no alternative way to solve the problems in mathematics. I feel mathematics is a very complicated subject and it is difficult to understand. Only those who are clever can take mathematics as an interesting subject. It is a boring subject for me. I have never tried to be good at mathematics since my childhood. I was never good at this subject and never would be good.*

Student expressions such as, "I am a weak student in mathematics class. I never liked math. It is a subject that only smart, intelligent students can read well and pass with good grades. I don't like mathematics subjects or mathematics teachers. This is one of the most difficult problems for me. I tried my best, but I couldn't do well. Mathematics has several complex formulas that I need to memorize. Without memorizing these dangerous formulas, there is no other way to solve mathematics problems. I think mathematics is a very difficult subject to understand. Only those who are active can regard mathematics as an interesting subject. For me, that's a boring subject. All these above-mentioned expressions reflect the mathematical anxiety of the students. From the above information, I generated the following theme and interpreted it.

Mathematical Anxiety

Mathematical anxiety is a psychological state that manifests itself in students when dealing with mathematical content, both in teaching and learning situations and in solving mathematical problems and assessing mathematical behaviour in practical life (Abbasi, Samadzadeh, & Shahbazzadegan, 2013; Alam al-Hoda, 2000). Only people who have very low personal strength can be easily diversified by focus, the reluctance of a good teacher to learn mathematics from an early age, and a suitable environment for learning mathematics primarily accustomed to suffering from mathematical anxiety (Budhathoki et al., 2022). It is also the consequence of an inability to deal with frustration, exercise, absence from school, a poor self-image, and the internalized negative attitude of parents and teachers towards mathematics through exercises without real understanding (Jain & Dawson, 2009).

In the words of Stuart (2000), the development of mathematical anxiety often stems from a lack of confidence in situations involving the need to manage digital information. Mathematical anxiety spreads like a contagious disease within a community, caste, region, or religion. Usually, students with a lack of sufficient knowledge to perform mathematics tasks and low mathematics self-esteem will reinforce mathematics anxiety, and, occasionally, relatively good mathematics students, also feel anxiety due mathematics to a lack of confidence in mathematics (Abbasi, et al., 2013). This means that mathematics anxiety seems to bother not only weaker students but also good students in mathematics as well. Belbase (2013) states that when thinking about anxiety related to math, two things may come to a student's mind, one is 'anxiety as progressive thought' and the other is "anxiety as regressive thinking". Both thoughts are not in vain, as mathematics anxiety is the way to improve learning, mathematics skills, and activity tips.

Classroom Vignette 10: Teaching of Profit and Loss Numerically

In the previous class on 5th December 2019, Sanjog explained the topic by subdividing technical terms, necessary formulae, symbols, and the meaning of the mathematical terms. I wanted to observe one more class on the same topic profit and loss. I observed this class on 8th December 2019.

Teacher: *Yesterday, we discussed the topic 'Profit and Loss' including the necessary formulae. I think you memorized the formulae that I enlisted on the board.*

Students: [Silent.]

Teacher: *Sabina, can you tell me the formula to calculate the profit percentage?*

Sabina: *Yes, Sir. The profit percentage is equal to S.P. minus C.P. upon C. P. times 100%.*

Teacher: *Raju, you tell me. Did you listen to Sabina?* [While Sabina was telling the answer, Raju was talking with the boy in front of his desk. The teacher had noticed it.]

Raju: *Umm … I did not listen well.*

Teacher: *Try to listen carefully to your colleagues and me. I am saying for your betterment.*

Teacher: *Rita, what did Sabina say?*

Rita: *Sir, I write on the board.*

Teacher: *Okay, you come on.*

Rita came and wrote on the board.

$$\text{Profit percent} = \frac{S.\ P. - C.\ P.}{C.\ P.} \times 100\%$$

Teacher: *Okay, you are correct. Go and sit at your place.*

Teacher: *Look carefully at the board everyone. I am going to do some sample problems for you.*

The teacher wrote the sample problem on the board.

A fruit seller purchased 100 oranges at Rs. 4 each. 20 of them were rotten and he sold the rest at Rs. 6 each. Find his profit or loss percent.

Teacher: *Babita, can you tell me what the C.P. in this problem is?*

Babita: *Yes sir. Sir, should I come there?*

Teacher: *Yes. You come here.*

Babita went nearby to the board, took the board marker with the teacher, and underlined the term "**A fruit seller purchased 100 oranges at Rs. 4 each**". Then she wrote.

No. of oranges = 100

Cost for one orange = 4

C.P. = 100 × 4 = Rs. 400

Teacher: *Babita, you have done well. Thank you. Go to your place. Here, I will solve this problem for you, and all of you, follow me. But do not copy during my explanation. I will provide you with enough time to copy what is written on the board. First of all, understand carefully.*

Solution:

Here, the no. of oranges purchased (N) = 100

The unit cost of orange (C) = Rs. 4

∴ Total cost of 100 oranges (C. P.) = N × C = 100 × Rs. 4 = Rs. 400

Again, the no. of oranges rotten = 20

∴ The remaining no. of oranges (N) = 100 – 20 = 80

The unit selling price of oranges (S) = Rs. 6

∴ Total selling price of 80 oranges (S. P.) = N × S = 80 × Rs. 6 = Rs. 480

As S. P. > C. P., there is profit.

Now, actual profit = S. P. – C. P. = Rs. 480 – Rs. 400 = Rs. 80

∴ Profit Percent = $\frac{Actual\ profit}{C.P.} \times 100\% = \frac{80}{100} \times 100\% = 20\%$

The teacher recited the above-written material thrice and tried to understand the students clearly. He provided enough time for the students to copy the problem in their exercise books.

Teacher: *Can you do this type of problem now?*

Students: *Yes, we can do sir.*

Teacher: *Okay, here is a problem for you.*

A fruit seller buys apples at 7 for Rs. 35 and sells them at 4 for Rs. 28. Find his profit or loss percent.

Almost all the students were busy solving the given problem. The teacher observed whether all the students tried their best or not and whether students followed the right way of solving the problem or not. The teacher waited for 5 minutes and told them why had not solved the problem. Yet, only a few students had solved the answer to the given problem.

Teacher: *I think many of you have gotten confused about this problem. I am going to do it for you. All of you please pay attention.*

Teacher: *Radha, can you tell me, what is the C. P. in this question?*

Radha: *Um,* [she whispered with her friends nearby her], *35.*

Teacher: *Rina, is she* (Radha) *right?*

Rina: *Right sir*.

Teacher: [Underlined the first part of the question]. <u>**A fruit seller buys apples at 7 for Rs. 35**</u>**, C**. P. is Rs. 35 but it is for 7 apples.

Teacher: *What is the C. P. for an apple? Gopal, please tell.*

Gopal: *C. P. for 1 apple is Rs. 5.*

Teacher: *Thank you, Gopal. You sit down.*

Teacher: *What about the S. P.?*

A boy: [Stood in his place and raised his hand]. *Sir, I know.*

Teacher: *Oh, Bhagat, you say.*

Bhagat: *The S. P. for 4 apples is 28 and the S. P. for 1 apple is 7.*

Teacher: *Sita, is your friend* (Bhagat) *right?*

Sita: *He…, he is right.*

Solution:
Here, C. P. of 7 oranges = Rs. 35
C. P. of 1 orange = $\frac{Rs.35}{7}$ = Rs. 5
Also, S. P. of 4 oranges = Rs. 28
S. P. of 1 orange = $\frac{Rs.28}{4}$ = Rs. 7
As S. P.> C. P., there is profit.
Profit = S. P. – C. P. = Rs. 7- Rs. 5 = Rs. 2
Profit Percent = $\frac{Actual\ profit}{C.P.} \times 100\% = \frac{2}{5} \times 100\% = 40\%$

Teacher: *Thank you, Bhagwat. You are right.*

Then the teacher did the full question connecting with symbols, formulae, and mathematical processes.

From the observation of the class, I found that the mathematics teacher tried his best to make the mathematical concept clear to the students. He focused on questions to the students, listening to their answers from the students, rechecking the answers, and further confirmation from the students. Although the students were able to answer the question partially or completely, the teacher explained it again so that other students also understood a lot. The mathematics teacher was deeply concerned with the formulae, the symbols, and the mathematical process. Despite the teacher’s full attempts at constructive classroom discourse, all the students could not participate in the classroom activity due to a large number of students in the class and their variable interests. Individual care of students was not ascertained in the classroom. Most of the time was spent in the teacher-centered lecture, explanation, and elaboration of the process. Less time was given to the problem-solving process. Many students were confused about expressing the mathematical terms and symbols from the verbal problem but they were able to use already established variable relationships/ mathematical formulae relationships in the problem-solving process. From the above information, I generated the following theme and interpreted it.

The Struggle of Solving Word Problems

Whatever the mathematics teacher did his best to make the mathematical discourse meaningful and suitable for the students, the students faced the great challenge of extracting mathematical terms from linguistics. Most of the students did not easily understand what was given in the text problem and what to find in it. However, some students understood what was given in the text problem, but they were unable to express it in mathematical symbols and what types of mathematical relationships were used. Clever students were also confused for the first time but came up with the idea of problem-solving after recourse to repeat the problem. The word problem was a challenge for the students to figure out what was given, how to express the correct mathematical symbols, which relate to the use, and how to perform the correct calculations.

Problem-solving is not only one of the most important components of studying mathematics; it permeates all aspects of life, including the real world. Problem-solving teaches students to be critical and ready-to-use thinkers, to hone organizational skills, and to build a rational thinking process necessary for making logical decisions (Pongsakdi et al., 2019). Students who solve problems will, one day, pursue technical careers and become researchers, inventors, designers, and engineers of the future. Problems with words tend to be complicated in part because of their descriptive language. Students often do not understand exactly what is being asked of them, especially when the problem involves abstract concepts (Jala, 2020). Other problems arise when students lack the basics of mathematics and cannot formulate a plan for solving or separating steps in an equation. Successfully solving mathematics word problems requires both mental representation skills and reading comprehension skills. Thus, it is assumed that the effective resolution of a mathematical word problem depends not only on the ability of students to perform the required mathematical operations but also on the extent to which they can accurately understand the text of the word problem (Fuchs et al., 2017). Two individual skills are relevant in this regard. First, an important factor contributing to a deeper understanding of the word problem text is the ability to build a rich and cohesive mental representation containing all relevant element solutions that derive from the textual basis of the word problem (Boonen et al., 2016). Word problem solvers should use a problem model strategy in which they translate the problem statement into a qualitative mental representation of the problematic situation hidden in the text (Jala, 2020). Word problem-solving skill is not easy for students, they require full concentration in the classroom, and come up with everyday practice.

After the end of classroom observation, we often talked about the classroom performance of teachers and the impact it has on the students. As all the teachers knew that I was also engaged in the same field, most teachers would ask me if I had a new technique for teaching mathematics. I used to tell them that mathematics teaching and problem-solving have different methods but a typical method of problem-solving has a universal way.

I went to School B, to observe Miss Usha's class on the 7th of January, 2020. Miss Usha was going to teach in class 8. This was the third period and the time was 12:15 pm. There were 32 students in the class consisting of 12 girls and 20 boys. The total number of students enrolled in that class was 41 at the beginning of the class. As time passed on, 5 students permanently left the class and 4 students were absent from the class on that day. There were 12 benches arranged in two rows containing 6 in each row. Two or three students were sitting on each bench. There was enough space in the classroom to arrange the benches in alternative ways so that teachers' access to students would be easy, but it was not done. There was a display board on the backside of the class. It was almost useless and no content of mathematics was found there. When we entered the classroom the students were roaming here and there in the class but feeling our presence in the classroom, they quickly moved to their right place and greeted us. We also greeted them and the teacher allowed them to sit down at their place.

Classroom Vignette 11: Teaching Set at Class Eight

Teacher: *Did you do your homework? Okay, raise your hands how many of you have done it?*

Students: [11 students raised their hands]. *We have done, Miss.* [Choral voice.]

One of the girls: [Stood up]. *Miss, should I collect the homework?*

Teacher: *Yes, please.*

She collected the homework notebook but 2 of the boys refused to give their exercise book.

Girl: *Shyam Krishna and Rojan did not give me their exercise books.*

Teacher: *Okay. You sit down, Binu.*

Teacher: *Students, those who have not done the homework, stand up.*

Students: [Those who had not done their homework stood.]

Teacher: *Tell me honestly, why did not you do your assignment?*

A boy: *Miss, I have done one and I did not know others.*

Next boy: *I was absent yesterday and I did not know about the homework.*

A girl: *I did not get enough time at home to do the homework.*

Next girl: *As soon as I reached home from school yesterday, I and my family members went to a neighbour's house to celebrate a birthday. It was already late at night when we returned home. But, I am sure, I will do it tomorrow.*

Teacher: *You all have to do your work by tomorrow. All of you sit down.*

Teacher: *Let us continue our chapter set. We did some basic concepts of it yesterday and I teach you some problems today.*

Students: *Okay, miss.* [Choral voice.]

Teacher: *This is question no. 5 and it is as below.* [Teacher wrote the problem on the whiteboard reciting with a loud voice.]

If U ={x: x is a positive integer from 1 to 20}, A = {x: 6 ≤ x ≤ 20}, B = {x: x ≤ 8} C ={x: 10 < x < 15} = {the integers between 10 to 15}. Carry out the following operations.

i. A∪B ii. A∩B iii. B∪C iv. A - B v. (A∪B)'

Teacher: *This is our question and it is somehow complex. So, all of you should pay attention to the board. I do not like unnecessary talks in the classroom. First of all, I will do the solution on the board and then explain it. You are not allowed to write while I am doing it on the board. First of all, you need to understand it carefully and then only copy it.*

Solution:

Teacher: *Here, the universal set (U) is defined as, <u>U ={x: x is a positive integer from 1 to 20}</u>. This means 'x' represents a number, ':' is 'such that' and after ':' you see there is quoted as, "<u>x is a positive integer from 1 to 20</u>". This means that you need to write the integers from 1 to 20.*

Here, U ={x: x is a positive integer from 1 to 20}

= {1, 2, 3, ..., 20} ['...', includes all the numbers from 4 to 19.]

One of the girls: *Ma'am, why did not you write all the numbers from 1 to 20 continuously?*

Teacher: *Yeah, we can write but it requires more time and space too. So, you need to understand that there are all the numbers hidden in a place of '...'. Here are only 20 numbers and you can write continuously if you wish. But, in the case of '1 to 500', what do you do? It is not possible to state all the numbers, therefore, we write a few numbers first then put '...', and finally, a few numbers of the last terms. I think you got it now.*

Students: *Yes, ma'am.* [Choral voice.]

Teacher: *Similarly, we can state sets A, B, and C.*

A = {x: 6 ≤ x ≤ 20} = {6, 7, 8, …, 19, 20} [Teacher wrote on the board.]

A boy: *Miss, what sign is this?* [Indicating '≤ x ≤'], I did not get it.

Teacher: [Wrote the indicated part of the problem and underlined it.] <u>6 ≤ x ≤ 20</u>. *This means you have to write the numbers 6 and more but 20 and lesser than it.*

Teacher: *For set B, we can write;*

B = {x: x ≤ 8, x є N} = {1, 2, 3, …, 7, 8}

A next boy: *Again, what is this like 'E'?*

Teacher: [Laughing…]. *Oh, this 'ϵ'. This is not exactly 'E' but it looks like 'E'. This is a Greek letter called 'epsilon'. x ϵ N, means 'x belongs to the natural number'.*

Teacher: *For set C, we have;*

C = {x: 10 < x < 15} = {11, 12, 13, 14}

A girl: *Miss, you wrote 6 to 20 for set A, and why are there 11 to 14 for set C?*

Teacher: [Wrote both conditions.] *Look here, for set A, we have* $\underline{6 \leq x \leq 20}$. *The sign is '≤'. This means 'less than and equal to' but for set C, look there is only '<', which means 'less than' but not equal to, therefore …*

Now,

i. A∪B = {6, 7, 8, …, 19, 20}∪{1, 2, 3, …, 7, 8}

= {1, 2, 3 4, 5, 6, 7, 8, 9, 10, …, 20}

Teacher: *A∪B (A union B), I think you know how to calculate this because you have done it many times.*

Students: *Yes, miss. We know.* [Choral voice]

ii. A∩B = {6, 7, 8, …, 19, 20}∩{1, 2, 3, …, 7, 8},

= {6, 7, 8}

Teacher: *A∩B (A intersection B), can you do this?*

Students: *Yes. We can do it all now.* [Choral voice]

iii. B∪C = {1, 2, 3, …, 7, 8}∪{11, 12, 13, 14}

= {1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13, 14}

Teacher: *Can you calculate this A – B (A difference B)? I think you can.* [Underlined the sign '-'] *this sign looks like a minus but actually in the 'Set' we pronounce it as 'difference'. For calculation of this A – B, you need to list all the set values of A and B put the difference sign between them, and then avoid the common values in both* *sets A and B. List all the remaining set values of set A but not of set B. Here, I do it for you.*

iv. A - B = {6, 7, 8, …, 19, 20} - {1, 2, 3, …, 7, 8}

= {9, 10, 11, …, 19, 20}

Teacher: *Do you have any confusion about it?*

Students: *No.* [Choral voice]

Teacher: *What about (A∪B)' (complement of A union B)?*

A girl: *I have not understood it very clearly. Please teach us how it is done.*

Teacher: *Well. First of all, you need to find the value of A∪B. Can you, do it?*

Students: *Yes, we have already done it in number (i).* [Few students reacted].

Teacher: *Okay. Then, to calculate the value of (A∪B)', you must find the difference of A∪B from the universal set U. The relation is, (A∪B)' = U - (A∪B).*

v. (A∪B)' = U - (A∪B) = {1, 2, 3, …, 20} - {1, 2, 3, 4, 5, 6, 7, 8, …, 19, 20}

= { } or ∅

A girl: *Why is this bracket empty and what is this next letter?*

Teacher: *Who can answer Manita's question?*

A boy: *I can.* [Raising the hand.]

Teacher: *Okay. Go on, Dhan Bahadur.*

Dhan Bahadur: *This bracket is empty because there is no set member in (A∪B)'. For the empty set { }, we can write phi (∅).*

Teacher: *Thank you. Sit down.*

During the observation of the classroom discourse, I found that students were irregular in the classroom, and out of 41 registered students at the beginning of the class, 5 of the students dropped out permanently from that class. Only 32 students were present and 4 students were absent on that day while I observed the class. Most of the students did not finish their mathematics homework due to being absent the previous day, lack of clear concept of the chapter, and/or students' personal reasons. Whatever the reason for the unfinished home assignment, the teacher only suggested the students to finish the next day but she did not revise the chapter. Students seemed to be confused about the mathematical symbols and their meanings. Before the start of the chapter, the teacher (un)knowingly used the phrases like, ... *and it is somehow complex; pay your attention…; I do not like unnecessary talks in the classroom;….., etc.* This helped the students to frighten of mathematics learning.

In this regard, Newton (2015, August 10) argues that teachers' attitudes toward mathematics can have a huge influence. Some of the teachers horrify the students by exaggerating unnecessary things. Teachers are instrumental in creating positive and active learning environments, such as by incorporating maths puzzles, and games into explanations and examples. By demonstrating an enjoyment and appreciation of mathematics, teachers can encourage a healthy relationship with the subject. And if teachers aren't quite comfortable with maths themselves, a good idea is to invest in professional development. The basic nature of mathematics including its language and the skills involved makes it difficult for students to learn (Abdul & Sarabi, 2015). The nature of mathematics like abstractness, accuracy, brevity, symbols, notations, and cumulativeness are dealt with as a part of mathematics.
After the class, I selected some students who had not done their home assignments in the classroom and asked what made mathematics a difficult subject. For my question, they told me their experiences.
A girl said, "*For me, mathematics looks scary because it involves several symbols and letters. In optional mathematics, the most complex maths symbols are Greek, and the popular expression of the level of difficulty experienced in understanding them. How*

could people make such difficult and dangerous formulae? I am scared to remember them."

A boy said, "*Mathematics is abstract, and everyone cannot solve the problem. Mathematics cannot be visualized. Especially, algebra is very dangerous. We have to memorize many formulae and different rules to solve the problems. Mathematics has different symbols that are very difficult to remember. During classroom discourse mathematics teacher does not forget to tell 'keep silence' and 'it is a very difficult topic'.*

From the students' voices, it was understood that the mathematics teacher also helped to scare the students by telling them that s/he was going to teach difficult topics. Students were demoralized by this activity of mathematics teachers. Almost all the teachers behaved as if they knew everything and students knew nothing and they put the gap between *'knowing everything and knowing nothing'*. This characteristic was discriminating against self and others. Teachers talk to the students like – *'it is a difficult topic', 'you are weak in mathematics', 'you cannot do well in mathematics', '…knows nothing', 'everything you did is wrong', 'you will not get good grades', 'you will not pass the exam', etc.*, are dominating, discriminating, and somehow oppressing steps that oppose the good classroom discourse in mathematics. In similar ways, the students' feelings about mathematics like – *'mathematics is only for talent students', 'mathematics is a harder subject', 'I don't have a mathematics mind, 'nobody in my family is good at mathematics', 'I get a headache when I think about mathematics', 'mathematics is a boring subject', 'mathematics has no use in our daily life', 'I am weak in mathematics', etc.* creates the mathematics anxiety to the students which makes the student suffer from mathematics phobia throughout their life (Budhathoki et al., 2022). However, in mathematics thinking positively from both students' and teachers' sides can help the improvement.

After knowing the views of students, I also wanted to know the teachers' perceptions of mathematics teaching. I requested Miss Usha for a little time to talk with me. She easily accepted my request.

BB: *In my classroom observation, I found that a few students were unable to complete their homework due to their absence, misunderstanding the classroom concepts, and others too. You just told them to complete the homework by the next day without revising the related topics, in this context, how can they do the homework by the next day?*

Usha: *Well, in my 15 years of teaching experience, I haven't got a single day that 100 percent of the student present in the class, and completed their homework fully. Every day, at least someone gets absent, and at least one doesn't complete homework. I'm tired of telling come to school and do your homework. But, as a teacher, it is my responsibility to be aware of them and teach them in a student-friendly environment as far much possible. If I repeat the topics for an absent student, the chapter would never go forward. I have understood it. Those who did not understand in the class, personally meet me in the school and learn.*

BB: *In your experience, how did you get mathematics teaching?*

Usha: *Simply saying, it's one of the most challenging tasks. Every day I encounter students with various problems due to their race, ethnicity, culture, language, socio-economic background, etc. Last year, I had two students, one was from India, who could not speak and read in Nepali, and another was from the Tamang community with the same problem. I was unable to handle them. I think the teacher is not an almighty God who knows everything. [Long laugh] …, I am also a bilingual person,* *with a fixed culture and environment but our classroom is a jumble of everything. In this scenario, mathematics teaching is more complicated.*

From the above information, I generated the following theme and interpreted it.

Symbols Dominated Mathematics

During the classroom discourse of Set, the mathematics teacher used different symbols like A, B, C, U, :, =, <, ≤, >, ≥, ∪, ∩, (A∪B)’, ϵ, { }, and ∅ in the same problem-solving process. These symbols have specific meanings. The students found them to be complicated in the problem-solving process, and many of them were confused. The same symbols have different meanings in the same problem, which is confusing for students, although experts can easily understand them. The following problem consists of too many symbols and their meaning in real life but mathematically they are the facts in the form of an abstract.

If U ={x: x is a positive integer from 1 to 20}, A = {x: 6 ≤ x ≤ 20}, B = {x: x ≤ 8} C ={x: 10 < x < 15} = {the integers between 10 to 15}. Carry out the following operations. (i) A∪B (ii) A∩B (iii) B∪C (iv) A - B (v) (A∪B)’

In the above problem, the similar symbol ‘U’ was used for ‘universal set’ in the first part, U ={x: x is a positive integer from 1 to 20}, and ‘U’ was also used for ‘union of two sets’ in the expression ‘A∪B’. This made the learners complex and they hardly remembered the meaning of the symbols in a few minutes of discussions. In the same line, Stenlund (2014) states that the lack of sensitivity to the conceptually significant features of symbolism makes it difficult to distinguish between philosophical and mathematical problems. The attitude of a mathematician is often that something only deserves to be called a real problem when it can be approached and solved mathematically. Mathematicians are masters in the use of mathematical symbolism, but learners require paying attention to symbolic practices in a perspective where the normal agreement in modern mathematical practices is developed. Our mathematical sign language is still heterogeneous and sometimes contradictory (Wegner, 2008).

The nature of symbolic mathematics has been concealed, and confused, however, it has played an important role in many of the great inventions in modern mathematics such as the introduction of the decimal place value system of numeration, analytic geometry, algebra, and calculus (Cajori, 2015). Mathematical conceptualization involves the integration of known knowledge and the assimilation of new knowledge into existing patterns. Symbols play an essential role in the integration of new knowledge. Mathematics is a language that has symbols, syntax, grammar, and a variety of representations. It also relies on the heavy use of different types of letters to represent variables, signs for numbers, diagrams, formulas, and algorithms (D'Entremont, 2015; Skemp, 1987). In the views of Schoen and LaVenia (2019), mathematics is a science of symbolic language and therefore, both the teacher and learners should play a constructive role to help each other, the core focus must be on the understanding of the meaning of symbols and their use.

Language Barrier in Learning Mathematics

After the observation of the classroom, I selected 4 students out of 37 and interviewed them separately, and involved them in the FGD. The students enthusiastically participated in the FGD in the peaceful environment of the school library. About an hour-long FGD was conducted. A small portion of FGD is presented below.

BB: *I think your mathematics teacher seems to be active and skilful to teach you. How much do you enjoy reading mathematics with him?*

Ritika: *Yes, he is very active and tries to make us understand as much as possible. When I first met him in this class, I could hardly understand him. But, I have a habit now. His tone of speaking is so funny. We used to laugh at him but we cooperate now.*

Rozy: *We didn't like him speaking English at first because we didn't understand what he was saying. Later on, we suggested him to teach in Nepali and he did the same. We enjoy learning mathematics now instead of his uneasy language.*

Sanukanchha: *Sir teaches well but I don't know mathematics very well. In my opinion, sir is biased because he gives more priority to the teaching of students from Terai districts. There are few students in our classroom having the same mother language as the teacher. They speak in their native language frequently but we don't understand what they speak about.*

Shristi: *Sir teaches well in the classroom but he has a very bad habit. He has a short temper. If he gets angry, he shouts in the classroom loudly.*

From the above FGD with my student participants, it was understood that not only do teachers face the challenge of the diversity of students' cultures but students have also encountered problems during the classroom discourse due to teachers' language, emotions, and biasedness toward some students of a certain community.

Mathematics is strongly connected with language, and to succeed in mathematics a student must be able to competently understand and use mathematical language as well as school teaching language other than the home language (Kazima, 2006; Sharma, 2015; Xi & Yeping, 2008). Technical language and mathematical vocabulary are not only essential for students to be able to understand and access the mathematics they are learning now but have a sign on their future mathematical development (Botes & Mji, 2010; Carranza, 1997; Xi & Yeping, 2008). The most efficient way to make meaning or create a concept of mathematics is in one's mother language. But, there is a lack of understanding among students because languages are different in our school and their home context. The 'official' mathematics is socially and culturally neutral in the context of Nepal (Panthi & Belbase, 2017).

In my observation, I found that a school fully funded by the government of Nepal had adopted the English medium mathematics textbook from a private publication**.** The school strictly followed the mathematics textbook issued by the CDC, Nepal for more than seven decades from its establishment. However, as the number of boarding schools increased in the locality, and many students and parents preferred teaching and learning in an English medium, the school adopted mathematics textbooks in the English language from private publications. In the same context, Meiers (2005) claims that when the language of instruction is English, students who learn English as an additional language are likely to experience language-related difficulties in mathematics. When English language learners cannot understand the language of mathematics because of language barriers, teachers need to use a variety of strategies to help with students' language acquisition and enhance their mathematical learning.

When I asked why there is a need to teach English medium in schools, a head teacher said,

> *Although there are only a few students in a class who are capable of learning the English language, we are obligated to teach in the English language and advertise as an English medium school. This is because, on the one hand, some students come to this school to study in the English medium. They do not study in this school if we teach them in Nepali medium. On the other hand, we have started teaching in the English medium to keep the students studying here in school, otherwise, we are unable to stop dropping them from school*.

Students and parents choose private schools if their economic status is strong enough and if they could afford the fees of private schools, due to the fashion of "*English medium school*". The community schools have also started teaching the English language to attract students to the community schools. The dropping of students from schools is the main problem. One of the mathematics teachers expressed his experience teaching in the English medium.

> *It doesn't matter whether you teach in English or Nepali language if the students are capable of understanding the language fully. Most of the students in the community schools are unable to understand the verbal problems in the English language but they are interested in learning in the English medium. Although we have used English mathematics books, the conversational language is surely Nepali. Even if the English book is kept, it is translated into the Nepali language while teaching. It is a mistake of students and parents to think that this is an English medium school only following the English language textbooks. With such thinking, the students are neither good at English nor the Nepali language. Such education has created more chaos.*

Teachers, teaching the English language are not satisfied with what they are doing. They said that though the books in the English language are used, the content is translated into the Nepali language while teaching the students. Most of the students have understanding problems in the English language. Students cannot express the answers in the English language as much better as they can in the native/Nepali language. Mathematics is a technical subject and the technical terms are written in the English language, students other than the native language of English find the mathematics content difficult. There is a growing demand for students' linguistic skills in mathematics lessons. Pupils at all levels are not only expected to listen, talk, and read but also to write about work in mathematical language. However, reasoning at complex cognitive levels through mathematical discourse is not something many students can achieve easily due to interference from everyday language and mathematical words (Goslin, 2016; Jorgensen, 2010; Morgan et al., 2014; Philp & Duchesne, 2016; Sharma, 2015). Therefore, students and teachers are getting difficulties in mathematics due to the existence of multilingual social realities in the same classroom and the practice of monolingual pedagogy.

Rather than viewing learning difficulties as a characteristic of the individual, I draw on Bourdieu's (1991) work to argue that the learning difficulties experienced by indigenous learners are an act of symbolic violence (Jorgensen, 2010). I propose that the practices within which mathematics is learned by students are structured in subtle and creative ways that limit the success of a particular group of students. Students fail to succeed in mathematics learning due to multiple reasons – language difficulties, cultural mismatch, physical and mental disturbances, the unfavorable environment in the school, etc. A Bourdieuian (1991) approach enables a richer theorization of the reproduction of power through school mathematics. Such an approach enables an understanding of why it takes considerably more effort for teachers and students to enable students from those backgrounds who are typically at risk of failing school mathematics to be successful in their study of this discipline.

Challenges in Mathematics Learning

Mathematics classes in Nepal are full of challenges from a lens of multicultural perspective, as classrooms in Nepal are multicultural, multi-ethnic, and multilingual in general, where students come to the school from different cultural and linguistic backgrounds (Panthi & Belbase, 2017). To manage these multicultural classes, mathematics teachers are confronted with multiple challenges such as the management of large classrooms, the control of the classroom, the choice of pedagogy, respect for cultural values, management of multilingual ideology, managing gender issues, knowing students' cognitive level, maintaining average grades, completing the syllabus in time, managing unit tests, monthly tests and exams, etc. Solving hundreds of these problems, convincing students and parents, and continuing the lesson is no less challenging work for mathematics teachers (Das, 2015). In the same context, Gates (2006) argues that in many parts of the world, mathematics teachers face the challenges of teaching in multi-ethnic contexts and multilingual classrooms containing immigrant, indigenous, migrant, and refugee children. Research must be useful, must address, and help us to understand these challenges. Since Nepal comes to exercise federal democratic systems, it has created additional socio-economic problems which have added more challenges for teachers in teaching and learning mathematics (Gardiner, 2002). Mathematics programs designed by experts and implemented by the government at all levels are incompatible with our culture. Foreign mathematical contexts are imposed on students and teachers which is regardless of the needs of the students, the diversity and values of our society, and the norms of Eastern culture (Panthi & Belbase, 2017).

In addition, there are other problems in teaching mathematics in the Nepalese context, such as getting to know the students well; understanding different learning abilities and skills of students; motivating and encouraging them when students are underperforming and under pressure from parents and peers (Beswick, 2018; Borasi & Brown, 1989). Mathematics teachers face three main challenges: their beliefs about teaching and learning; their content and pedagogical knowledge; and reflection time (Acharya et al., 2021). Most teachers showed the economic crisis of administration, lack of supervision, lack of adequate teaching environment, lack of awareness of students in mathematics class, lack of adequate teaching plans and materials, lack of student participation, and low level of student experience, lack of pre-service and in-service training; lack of ICT training for updating knowledge (Beswick, 2018; Zant, 1943). In this way, mathematics teachers have faced many problems and do not have the proper needs to support meaningful, joyful, constructive, and student-friendly classroom discourse.

Chapter Summary

In this chapter, I explored the challenges that mathematics teachers and students face due to various circumstances in the classroom. Triangular analysis of the dataset from in-depth interviews, FGDs, and classroom observations elicited various themes. These themes were – challenge of classroom teaching with dual language; teachers emphasizing written discourse over verbal discourse in teaching mathematics; mathematics in the eyes of students; strategies for addressing students' learning difficulties; formulae dominated mathematics classes; mathematical anxiety; the struggle of solving word problems; symbols dominated mathematics; difficulty in mathematics due to teacher's language; language barrier in learning mathematics; and challenges in mathematics learning. Challenges faced by students and teachers were thematically discussed with the relevant scholarly works and theories adopted in the theoretical framework.

CHAPTER VIII

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

In this chapter, I have discussed about the summary and drawn conclusions based on the information collected, analyzed, and presented in the previous chapters.

Existing Classroom Pedagogy

The first objective of this study was to explore existing discourse in mathematics classroom among school-level students in a natural setting. To accomplish that objective, my research question was 'how is the existing classroom discourse of mathematics teachers in mathematics classrooms? With the help of live information and multilevel analysis, I found the following output.

The teachers started their classes by reviewing the previously taught contexts and gradually they moved to the problem-solving method with a dialectical discourse between the students. If the students could solve the given problems, the teachers acknowledged their efforts, encouraged them, and initiated a problem-solving method that leveraged the students' efforts. If the student did not have an idea to solve the problem, the teacher taught the method of solving the problem step by step by exchanging ideas between the teacher and the student. After solving the problem, the teacher gave a similar problem to the students and they could solve it easily. Mathematics teachers tried their best to make the concepts of mathematics clear to the students. If the students were able to answer the question partially or fully, the teachers re-solved all the problems so that all students in the class could clearly understand. Teachers were engaged in classroom lectures, explanations, problem-solving, drawing geometric figures, correcting class assignments, and homework.

The interactive teaching method enriched knowledge and developed skills, developed attention, the spirit of observation, memory, and imagination, forms motivation and attitude toward various activities, cultivates the spirit of inquiry, perseverance, and the spirit of cooperation. Although I did not see the lesson plan prepared by the teachers in everyday activities, they were conceptually prepared on what they were going to teach and how to teach it to make the classroom discourse student-friendly. Students were also motivated to find the teaching materials used by the teacher to explain the concerned lessons and there was competition among the students to prepare better teaching and learning materials. Some of the teachers (Raj, Nayantara, Usha, Kanchan, and Hari Sing) prepared the teaching materials collaboratively with the selected students. Teachers would previously notice to the students what they are going to teach the next day and what instruments, and materials should students have to prepare to learn effectively.

Mathematics teachers were well known for the curriculum, textbooks, practice books, assignments, class works, and different tests to optimize the learning experiences of students. Teachers have had the experience of engaging students in the classroom with the immense use of examples. Teachers provided all the necessary support for the appropriate learning experiences for all children. These learning experiences, informed by the curriculum, were designed to support all children's needs, interests, and abilities. The teacher's knowledge of the children and their prior learning; their knowledge of the curriculum; and their knowledge of pedagogy seemed to be appropriate for the smooth run of classroom activities.

The young teachers had a positive attitude towards the use of ICT in mathematics although they had never been trained for ICT application in mathematics. The young teachers were enthusiastic about applying ICT in mathematics teaching and they have been using ICT-integrated pedagogies in classroom teaching. The old-aged teachers were challenged with ICT-friendly classrooms as they were not sufficiently trained for the application of ICT in mathematics classrooms. It took a lot of time to arrange the ICT tools and again technologically weak teachers faced more challenges adopting digital media. Only a few numbers of teachers (3 out of 12) had received ICT-based training in teaching, using the latest technology.

Engagement of Students and Teachers

Students' participation in the conversation, performing classwork, answering the teacher's question, making cultural artefacts as learning materials, and performing lab work and fieldwork was very appreciable. Students had been actively involved in the teaching-learning process when they were brought to the mathematics laboratory to measure the dimensions of solid objects. Teachers' experience allowed learners to meaningfully observe and practice their skills and support the scaffolding, teacher-assisted activities, or more competent peers. In classroom activities, there was ample social interaction and some students played the role of peer supporters to less capable students. In this sense, Vygotsky's (1978) zone of proximal development theory and sociocultural theory were relevant and were exercised in classroom activities unknowingly.

All the classrooms that I observed were multicultural in the sense of languages, religions, castes, socioeconomic backgrounds, and ethnicity. Teachers helped the students by making the teaching materials, project works, charts, and teaching models where the students' cultural connection to mathematics was exposed among their classmates. The teaching from the cultural artefacts helped students to connect mathematics with their existing cultures. In classroom instruction, teachers used local cultural artefacts, models, and teaching materials that helped students integrating local mathematical resources and generate and acquire new knowledge. Integrating the arts into the mathematics classrooms provided students accessing to content, and multiple perspectives on a topic, and invited them to think, apply, understand, create, and participate in their learning. Students learned and understood to contribute to 'getting on in life' or 'social status', i.e., being able to perform well in school, knowing how to talk in different social groups or societies, accessing higher education, and being successful in work or a career what Bourdieu called cultural capital (1986).

The classrooms reflected the diversity of mini-society in the same perspective where students and teachers respect each other's culture knowingly or unknowingly in a democratic classroom and this activity has reduced ethnocentric attitudes and stereotypes by creating equal educational opportunities for all students regardless of race, ethnicity, class, and cultural origin, to effectively link the social issues of race, ethnicity, and culture to the educational process. Teachers organized the project work, fieldwork, and drawing competitions repeatedly that could be done in groups of students with the help of classmates and multiple ideas. A group of students of different ethnicities working together at a desk on a shared assignment was remarkable collaborative learning. In cooperative learning, students worked together in small groups on a structured activity. In small groups, students could share their strengths and also improve their weaker skills. When cooperative groups were guided by clear goals, students engaged in many activities that enhanced their understanding of the subject matter of mathematics. In the group works, students actively participated and the teachers acted as facilitators. Students had acquired the skills to resolve conflicts when they arise in group work. Groups of five or more students worked together to solve problems, complete tasks, or learn new concepts.

Group work of students maximized the educational experience by demonstrating the material while improving social and interpersonal skills. Collaborative learning provided the golden opportunity to work with different types of students and develop their leadership skills which seemed to be based on social constructivism mentioned by Vygotsky.

Mathematics teachers helped students better understand mathematics by presenting multiple examples, encouraging collaboration on alternative solutions, and framing the class with a clear agenda and effective summary. Next, teachers posted and articulated the learning objective or essential questions to the class so that students know the purpose and, at the end of the lesson, can self-assess whether the objective had been achieved them. The teachers believed that the more types of representations they could present to students to cater to their different learning styles, the more likely students truly understood the concept being presented in class.

Students who were exposed to and made able to recognize the same relationship placed in the different modes of representation were more likely to have a conceptual understanding of the relationship and performed better in assessments. In the best classroom environment, teachers were able to show different ways to solve the same problem and encouraged students to find creative ways to solve them. More strategies and approaches were exposed to make a clear understanding of the students what was taught in the classroom. After an individual, pair, or small group of students, finished solving the classwork problem using one method. Teachers encouraged students to find other ways to solve the same problem, thinking that by teaching multiple ways of solving problems, students would learn better ways.

Mathematics teachers were concerned about student motivation while performing teaching-learning activities. Teachers were more focused on students learning and they treated students individually, in a pair, and in small groups to maximize the activities in the classroom. The fearless environment in the classroom motivated students to ask teachers whatever students found difficult in the problem-solving process. Mathematics teachers argued that it is necessary to provide a clear concept of mathematics and confirm whether the student understood, by questioning orally or making to write on an exercise book or the whiteboard. Saying that the practice makes a perfect man, either way, the strong concept was built through the practice and if there was a lack of frequent writing practice, students forget problem-solving techniques.

The majority of the teachers (for eg., Raj, Usha, Kanchan, Nayantara, Hari Sing, and Sanjog) allowed their students to create their own questions and this allowed the students to have fun and actively participate with enthusiasm in creating different types of problems from their imagination, which was considered a deep understanding of what was taught and the construction of new knowledge underlying new problems. Students were allowed to solve problems that they have created themselves using several methods and the teacher helped students solve the problems in real time and real from the students' experiences. Participation in discussions and exercises certainly helped students develop their problem-solving skills and develop the habit of developing new problems. The student-friendly and multicultural assimilation pedagogic activity were supportive factors to make classroom discourse relevant to the changing environment.

All the teachers agreed to enhance the knowledge of students with the help of productive activities in the classroom discourse but denied equality them. Teachers also agreed to provide equal opportunities in the learning process but in accord with the in-built or acquired skills in mathematical knowledge, performance, attitude, and passion that make the students dissimilar from each other, and the same is stated in the theory of multiple intelligence (Gardner, 1983). From the teacher's statement, it was clear that students' mathematics learning was reflected in the attitudinal behaviour they exhibited in the class during classroom activities.

Teachers allowed their students to make physical movements to activate the learning energy within them. Teaching certain chapters, such as height and distance, mensuration, and solid figures, teachers took their students to the mathematics lab and to the field to familiarize themselves with measurements of the land and the observation of the shapes of solids. Students and teachers both preferred project-based teaching and assignment which helped learners to disclose their intrinsic abilities.

Mathematics teachers were aware and skilled to handle and manage the students in the classroom teaching according to the students' personal behaviour. Mathematics teachers were very aware of racial, religious, ethnic, sociocultural, and socioeconomic issues. Supporting all the issues of the communities like ethnicity, religion, sociocultural, socioeconomic, lingual, etc. was one of the ways of being multicultural in the classroom discourse of mathematics. On the other hand, being neutral to all these issues was also one of the ways of being non-controversy in the multicultural mathematics classroom, which was not possible in practice because the teacher was also one of the members of the community.

Therefore, it was better to support all the social, racial, religious, linguistic, and economic issues very carefully instead of being neutral in the multicultural classroom. Mathematics teachers were a supporter of the issues of cultural diversity and multiculturism as they claimed in their personal interviews. Mathematics teachers respected the unique identity of each student in terms of culture, language, and religion. Mathematics teachers also claimed that mathematics curriculum and textbooks are the major sources of mathematical knowledge and they should incorporate multiculturism reflecting our diverse society. Mathematics teachers strongly advocated that they are only the medium of knowledge transfer from mathematics textbooks to the students by applying multimethod pedagogic strategies but curriculum and textbooks should also incorporate the issues of multiculturism of the society accordingly. Mathematics teachers claim that mathematics is encrypted everywhere in our everyday life but it needs to be viewed through the lens of mathematics.

According to mathematics teachers, mathematical artefacts are very simple, familiar, cultural, and meaningful objects through which abstract mathematical logic is carried into visionary models. Our everyday experiences of working with *Thanka* paintings, *Theki and Madani*, *Doko and Dalo*, *Nanglo and Chalno*, *Madal*, *Damphoo, Sahanai*, statues, and

Rangoli made in *Tihar* also encrypted mathematical ideas and can be used as the mathematical teaching ideas and models but teachers claimed that they were not incorporated in our mathematics curriculum. Existing mathematical ideas encrypted in cultural artefacts need to be connected in our classroom discourse of mathematics to make mathematics teaching interesting, meaningful, and permanent. Artefacts can be seen as a mapping that transforms abstract ideas into concrete, powerful, and meaningful images that evolved with different objectives in different social and cultural contexts.

For classroom discourse, the artefacts displayed in the mathematics class were specific materials that children often encountered in real life. In the context of Nepal, mathematics is taught to students what is given in the textbooks of mathematics but real and applied mathematics is found everywhere in our daily life. If students are taught to explore the hidden mathematics in our daily life and our every function, students will make the mathematical concepts in their daily work. This would lead to connecting bookish mathematics in their socio-cultural activities and would never lag behind mathematics learning.

Mathematical thoughts and thinking are embedded in every ecological activity of a group of people; however, their mathematical thoughts in their daily work are still largely hidden. Informal and hidden mathematical ideas and knowledge practiced and used in daily activities are the source of understanding abstract mathematical ideas. A cultural group of students can clearly understand school mathematics in their related fields.

Ways for Promoting Student-Friendly Classroom Discourse

The school would provide a strong physical condition of safe drinking water, clean toilet facilities, library facilities, science, and mathematics laboratory facilities, and a child-friendly school environment. Children are given access to modern facilities like computer education according to their level. Individual attention is given to overcoming learning difficulties through learner-focused teaching. Students are given opportunities to learn through collaboration, teamwork, fieldwork, experiment verifications, practical involvement, and discussions with expert teachers to improve cognitive and logical power. Providing students with opportunities to participate in local, regional, and national level competitions to show their talents can support in learning. Monitoring and evaluation of every teaching and learning activity are ensured through internal and external institutional support. Learning achievements are shared with parents, the community, and supportive institutions to encourage children to excel in curricular and co-curricular activities. High achievers, competitors, winners, and runners-up are appreciated in the community programs to boost their courage. Every event or activity should be periodically organized and learners' development and achievements should be extended locally and globally.

A fearless classroom environment can be created by managing or designing small group work consisting of imagination, passion, curiosity, and adaptation for the students. The ideas, struggles, successes, failures, and questions still lingering, are the magical moment where every student feels validated and needed as a contributor to the greater learning of the classroom (Budhathoki, 2020). Students were found more successful when the course materials were appropriate for their developmental stage and academic ability. Providing students with clear expectations and timely feedback encouraged students to participate and learn because they had a better ability to do so. Supportive, positive, and responsive teaching methods helped to create a fearless teaching environment in the classroom. Assessment structures promoted learning when they offered time for feedback and growth and embodied various ways of understanding.

Students were well-known in the classroom for their unique behavioural activities. Every student was known for being clean, positive, good at problem-solving, curious, hardworking, social, behavioural, polite, slow learning, having problems, having different skills, impolite, and aggressive.

Students liked the experience of the teaching facilitator in the classroom, which was to gradually get to know the students at a cognitive level and motivate them accordingly. Teachers needed to personally understand students' interests, behaviours, and culture, although it was difficult to follow in practice. When teachers understood the problems in the real world, students would face and try to solve these problems, then every student would participate in teaching activities.

By simply sitting in the classroom, listening to the teacher, memorizing the prepared homework, and reciting the answers, students would not learn much. Knowing students' personal problems, economic and social backgrounds, interests, struggles, cognitive levels, and learning styles, and providing personal support and need-based support showed a big improvement in students' learning.

My participant teachers said that they asked their students to create their own problems frequently when the mathematics lesson was finally over. They assured that students enjoy and actively participate enthusiastically in making different types of problems of their self-imagination which was seen as the understanding of the taught lesson carefully and the construction of new knowledge underpinning the new problems. When students constructed a variety of problems, the teacher asked them to exchange the student-made problems in small groups, solve them, and share them among the groups. Participation in discussions and exercises effectively helped students expand their problem-solving skills and promote the habit of developing new problems.

Nowadays, mathematics requires not only computer knowledge but also the ability to think and reason in mathematics to solve new problems and explore new ideas that students will encounter in the future. By planning and promoting courses, teachers could actively engage students in mathematical thinking. Experienced teachers encouraged students to share their knowledge of this idea through oral, written, and applied methods.

Mathematics teachers were aware of racial, religious, ethnic, sociocultural, and socio-economic issues. Supporting all the issues of the communities like ethnicity, religion, sociocultural, socio-economical, and linguistic teachers addressed the values of multiculturism of the society. Mathematics teachers also claimed that mathematics curriculum and textbooks are the major sources of mathematical knowledge and they should incorporate multiculturism reflecting our diverse society. If the mathematics curriculum and textbooks reflect the multicultural society, then only teachers play the role of multicultural mathematics teachers. The mathematics teachers, educators, and head-teachers strongly accepted our nation's multicultural practice. This type of cultural dominance indirectly made particular races of students weak in mathematics. Various cultural festivals affected our mathematics teaching and learning. Due to local festivals, the students became absent for many days.

Teachers believed that Nepal has cultural inequality and this unequal cultural practice influenced challenges in mathematics teaching and learning. The teachers claimed that mathematics was encrypted everywhere in our everyday life but it needed to be viewed through the lens of mathematics. Mathematics was everywhere if one viewed it from the mathematical lens.

Existing mathematical ideas encrypted in cultural artefacts need to be connected in our classroom discourse of mathematics to make mathematics teaching interesting, meaningful, and permanent. Artefacts could be seen as a mapping that transforms abstract ideas into concrete, powerful, and meaningful images that evolved with different objectives in different social and cultural contexts. It helped to understand abstract ideas by mapping them into powerful and meaningful images created in fundamentally different environments.

All the head-teachers raised their voices on practical teaching through the existing mathematical models scattered in our everyday practice and cultural heritage.

If students were taught to explore the hidden mathematics in our daily lives and our every function, students would make the mathematical concepts in their daily works, and they would try to connect bookish mathematics in their socio-cultural activities and would never lag behind mathematics learning. Mathematical thoughts and thinking were embedded in every ecological activity of a group of people; however, their mathematical thoughts in their daily work were still largely hidden. Mathematical anthropology uses mathematical models to describe the material and cognitive models of specific groups of people in history, ethnography, and material for cultural studies.

In the conversation, the teacher easily assured the benefit of ICT application in the classroom pedagogy of mathematics. The use of ICT was seen as the application of simple and scientific calculators to solve complex problems in a simpler and faster way. Students could use ICT to perform calculations, draw diagrams, and helped to solve problems. The most obvious example of using ICT in this way was when students used calculators or something similar to perform more complex calculations.

Students used ICT as a tool to discover things, solve problems, or understand what was happening, and often helped them develop skills in the use and application of mathematics. The head-teachers also emphasized the use and benefit of ICT-integrated education in the classroom as well as the students' and teachers' personal use.

Head-teachers claimed that the young teachers were capable of using ICT in the classroom but the old ones were poorly well-trained and less interested in the field of ICT, which was creating a bit problem in schools. They advocated that none of the teachers and students would stay behind the ICT in the age of science and technology, although there were a few problems in the current situation. A few teachers still did not trust the use of technology. So, they needed additional training.

The use of ICT in the classroom discourse of mathematics could integrate multiculturism because the teaching contexts, style, methods, and accents were created by people of various cultures, societies, cognition, religions, and languages. Integrating ICT into classroom pedagogy made it easier to understand mathematics content because educational materials existed in many forms, from simple to complex, and were provided in the form of text, sound, animation, graphics, and equations, making it easier for students to understand different cognitive levels in a multicultural environment. Students and teachers both benefitted from the application of ICT in classroom teaching, students would simply understand the background, class culture, and socioeconomic stands of various festivals of different castes, languages, and religions. The use of ICT in mathematics classes can improve learning efficiency and improve students' ability to understand basic concepts. In doing so, there were many barriers to using ICT in the classroom such as teacher competence, teacher motivation, teacher training, physical facilities, and financial support.

Collaboration and motivation were seen in the task of project work to self-reflect on learners’ experiences in the classroom discourse of mathematics. Similarly, the teachers established the proper rapport with the students and created a child-friendly environment in the classrooms to reflect the learners’ information. In the same way, the teachers motivated the faster learners to support the slow learners in the classroom. I found triangulation among teachers, parents, and learners to form an inclusive learning environment in the classroom. It was found that mathematics teachers focused on integrating multiple ideas in the classroom using new emerging methods such as think-pair-share pedagogy, flip pedagogy, and STEAM pedagogy.

In terms of managing the classroom, mathematics teachers made different groups of students, counseled them to improve their learning activities, tried to use the learners' mother tongues in the classrooms, and encouraged the neighboring students to communicate with their friends. To teach the learners, the teachers used the social constructivism theory, where the students actively participated in learning and constructed their concepts regarding the situations.

Similarly, mathematics teachers focused on students' collaborative learning activities, helping them create student-friendly environments in their classrooms, participate in various activities, and help their weak peers raise their standards. The learners' proficiency level could be improved with the proper use of continuous motivation.

Challenges Faced by Teachers and Students

Mathematics teachers had a difficult job completing the lesson over time while meeting student aspirations as they fostered an open classroom and enjoyable environment. One of the big challenges to mathematics teachers was the frequent absence of students in the classroom and the incompleteness of the homework. Students, especially from the Chhetri and Brahmin communities, used Nepali as a colloquial language in their homes and schools, while English was used to learn mathematics. However, some students from the Magar, Rai, Limbu, Tamang, and Newar communities used their mother language at home, Nepali as the spoken language in school and English as the language of mathematics learning. The lingual disparity also added to the difficulty of teaching-learning between students and teachers. Community schools used Nepali as the language of discourse and English as the written language in mathematics classes. Therefore, both students and teachers faced the challenges of lingual differences between their mother tongue and the school language.

Different cultural festivals affected mathematics learning. The Newari community has unique cultural practices in some ethnic groups, such as wood apple marriage (*Bel Vivaha*), cave-keeping (*Gufa Rakhne*), and various local festivals (*Jatras*), and the children of this community are often absent from these local ceremonies. This type of cultural practice in society has added complexities to the classroom discourse as some groups of students become absent for several days in the school due to their local rituals, which ultimately, weakens them in mathematics learning. In this regard, Bourdieu's Cultural Capital Theory (1986) was found to be inappropriate in the context of Nepali classroom discourse in mathematics because the existing culture of some groups of students created more challenges than support.

Students who viewed mathematics as a difficult subject entered the class with less interest and did not even complete their homework on time. Some students found mathematics to be an easier subject because they were enthusiastically involved in-class activities and even completed their homework on time. The students agreed that they gave mathematics less priority because of the difficulty in memorizing different formulae in each topic and the new rules for solving problems. In most cases, some students simply copied their classmates’ homework and presented it to their teacher without understanding the topics.

A few students (6 out of 32) claimed that they understood other subjects easily but did not understand mathematics as easily as other subjects. Students viewed mathematics as a school subject that is used in a variety of contexts in everyday life, at work, for learning other subjects, and for future study. Students found mathematics as a form of exercise or mental activity that is used to develop intellectual and problem-solving skills. Students viewed mathematics as a group of numbers and rules for doing calculations.

The basic nature of mathematics, its language and the skills involved made it difficult for students to learn. Students faced challenges in memorizing mathematical relationships, geometric interpretations, and solving verbal problems. The students were confused about expressing mathematical terms and symbols from the verbal problem but they were able to use the already established variable relations and mathematical formulae relations in the problem-solving process. Students who do not come to school regularly, do regular homework and do not pay full attention to learning activities find mathematics a difficult subject.

It was clear from the students' voices that even the mathematics teacher had helped to scare the students by saying that they were going to teach difficult subjects. The students were disappointed with the mathematics teachers' activities. Teachers talk to students – this is a difficult subject, you are weak in mathematics, you cannot do well in mathematics, you do not know anything, everything you have done is wrong, you will not get good marks, you will not pass the exam, etc., were dominant, discriminatory, and somehow repressive measures used by teachers and that behaviour opposed the student-friendly classroom discourse in mathematics and increased the anxiety level.

Similarly, the student's attitudes toward mathematics like, 'mathematics is only for talented students, mathematics is a difficult subject, I don't have a mathematical mind, no one in my family is good at mathematics, it is a boring subject, mathematics is of no use in our daily life, I am weak in mathematics, etc., had increased the anxiety level in the learning of mathematics.

Conclusions

The classroom discourse in the mathematics classroom varies with the teacher's authority. Classroom discourse in mathematics is interactive, debating, logical reasoning, full of small group discussions, collaborative, and student-friendly although some mathematics teachers follow traditional practices, with the teacher playing a central role in delivering content through lectures, memorizing formulae, textbooks, and exercises. There is limited access to teaching materials, including textbooks, manipulatives, and technology. There is a trend towards rote memorization and repetitive practice of mathematical procedures which limit opportunities for critical thinking and problem-solving.

From the personal conversation with head-teachers, mathematics teachers, and mathematics educators, it is articulated that discourse in mathematics classrooms is culturally rooted and could be easily experienced in our everyday activities. To build strong cultural connections, schools can take active steps to make students feel welcomed, accepted, safe, and valued from diverse cultural backgrounds. School activities can also incorporate multicultural songs, dances, and performances that reflect the cultural diversity of the students.

According to the head-teachers, the school is the place where the overall progress of students develops: intellectual, physical, emotional, psychological, social, and cultural development. Nowadays schools and teachers face a big challenge in recognizing and addressing interesting fields of study for students. Students are energetic, and if not guided adequately in the constructive roles of reading, writing, extracurricular activities, and games, they can abuse their potential and become the characters of hate. School head teachers expect teachers to manage student behaviour through their creative, participatory, and constructive roles in the classroom.

Effective teaching methods require demonstration, group discussion skills, role-playing, and problem-solving. Students are given opportunities to learn through collaboration, teamwork, fieldwork, experiment verifications, practical involvement, and discussions with expert teachers to improve cognitive and logical power. Students often make mistakes while solving mathematics problems but the teacher continues to correct them without worrying about it and the students learn by forming small groups in the classroom so that they can understand everything and solve problems independently. The teachers try to make the students stress-free by creating a student-friendly environment in the classroom.

Head-teachers prefer strong physical conditions of safe drinking water, clean toilet facilities, library facilities, science, and mathematics laboratory facilities, and a child-friendly school environment that helps in learning mathematics resourcefully. On behalf of the students, they actively participate in educational exhibitions, and project-based learning collaborating in the maximum use of libraries, mathematics, and science laboratories, and enriching their knowledge individually.

Usually, teachers are more worried about unproductive students because they are frequently distracted from their learning in the classroom. The mathematics teaching style is somehow traditional, rote-learning, and bookish rather than explorative in everyday functions and cultural artefacts.

The head-teachers of the schools are also aware of the use of ICT in the classroom pedagogy in different subjects including mathematics teaching. They claim that young teachers are capable of using ICT in the classroom but the old ones are poorly trained and less interested in the field of ICT, which is creating a bit problem in schools. The ability of ICT to display text, images, sound, graphics, animation, and video provides an excellent opportunity for teachers to create interactive and engaging learning experiences, however, many teachers lack the skills required to use ICT effectively in the classroom.

Most of the mathematics teachers (9 out of 12) accept that the use of new emerging technologies helps in the teaching-learning process. The use of ICT in teaching mathematics can make the teaching process more effective and enhance the student's capabilities in upgrading basic concepts. Adequate time is allowed for teachers to develop new skills in using new technologies and explore their integration into their existing teaching practices. The government and school administration are positive to create a good opportunity to provide training to the teachers, who lag behind in making use of ICT skills.

The students feel problems in learning mathematics because of the difference between their home language and their teaching language. There is a communication problem between teachers and students in mathematics classrooms. This is one of the challenges in mathematics teaching-learning activities as the teachers and students have different linguistic backgrounds. The students face problems due to the colonized mathematics which results in mathematical anxiety on the part of learners. The centrally prepared curriculum merely considers cultural diversity therefore teachers face professional challenges. In a multicultural setting, teachers are not sufficiently trained to a greater extent in the knowledge of pedagogy that suits such a classroom environment. The teachers are found incompetent in teaching mathematics in multicultural situations as they are not trained to teach to their full potential. Further, the pedagogies they use are found mono-cultural using the Nepali and English language only.

Teachers are prepared for teaching before conducting classroom activities and making teaching materials. All the teachers know that their classrooms are multicultural-based and although they do not know how to apply multicultural teaching activities, but all of them use multimethods in teaching mathematics. Teachers emphasize the written practice encoding “practice makes a man perfect”. As I conceptualize the different phases of classroom activities of students as well as teachers, teachers mostly focus on the elaborative phase and recapitulation phase. Students are equally involved in the preparatory phase, understanding phase, exercising phase, and questioning phase to enhance their mathematic knowledge. Teachers use multimethod pedagogy to address culturally diverse classrooms, such as student-teacher discussion, student-student discussion, student presentation, explanations, and elaboration with examples. Mathematics educators argue that teachers are the epicentre of the creation, interpretation, implementation, and transformation of classroom pedagogy. There are other factors including teachers, administration, guardians, curriculum, socio-cultural practices, socio-geographical situation, and environment of teaching institutions to promote classroom discourse of mathematics. Mathematics teachers apply multimethods in their classroom discourse such as the think-pair and share method, flipped pedagogy, and STEAM pedagogy to make their students creative, collaborative, and enthusiastic in learning.

Teachers and students faced challenges from the existence of linguistic inequality, and multiculturalism in the classroom because it functioned as a micro-society but we have a mono-cultural and monolingual classroom pedagogy. Some cultural and traditional practices of Nepalese society such as wood apple wedding (*Bel vivaha*), cave keeping (*Gufa rakhne*), and not sending girls to schools during the first menstrual cycle for many (up to 12) days opposed the classroom discourse in mathematics weakening to students and adding challenges to teachers to accommodate the equitable pedagogy. Marginalized and victimized groups of students were oppressed by traditional and cultural practices in society which creates difficulty in equal participation in the classroom. Classrooms reflect the diversity of a multicultural and multilingual society, but monocultural and bilingual classroom practices are inappropriate for a student-friendly classroom. Now, teachers are challenged to use multicultural, multilingual, and multimodal teaching to address the diversity of all students. Appropriate teacher training that integrates classroom cultural diversity can address student learning opportunities in several ways.

Implications of the Study

This study explored some possible zones for further research to develop the overall effectiveness of classroom discourse in mathematics classrooms in multicultural settings in Nepalese Schools. Some of the implications are as follows:

Policy level implications. Policy implications refer to employing the research findings in the classroom activities of teachers and students. A school can make student-friendly policies, planning, techniques, and programs to promote the cultural embedding of students. This activity can lead to a good and activity-based school in the community. The curriculum planners and textbook authors can integrate an embodied culture of the country into the mathematics curriculum and textbooks.

Program implications. Head-teachers and mathematics teachers can design effective programs to address the weaknesses of classroom discourse in mathematics. Community schools may give higher priority to mathematics and administer additional classes to students who are weak in mathematics. Mathematical activities can be addressed in extracurricular activities. Community school stakeholders such as principals, and resource centre mathematics teachers can conduct joint programs to raise the level of students' mathematical knowledge. Local governments, INGOs, and NGOs can raise funds and organize effective programs to integrate local resources and cultural heritage into mathematics teaching and learning activities.

Pedagogical implications. The teachers can seek new strategies, methods, and techniques in mathematics classrooms by collaborating with students. Collaborative learning may lead to the success of students and can uplift the overall achievement of students in mathematics.

Motivational implications. This study provided me with self-satisfaction and enhanced my teaching activities in the classroom. As a mathematics teacher, I learned how to employ and address the diversity of students' multiculturalism in the classroom discourse of mathematics. Likewise, mathematics teachers and other researchers can be motivated to explore and address the multiculturalism of nations in classroom discourse. I hope that the beginning of the integration of multiculturalism in mathematics teaching-learning can motivate mathematics teachers and students to explore more areas in the future.

Theoretical implications. Findings from this research can help novice teachers integrate cultural connections into mathematics in the process of teaching mathematics in the classroom. Student-friendly classroom discourse in mathematics is much needed to improve the overall educational approach. Mathematics teachers can use the findings of this study to enhance their pedagogical process on the integration of culture, inclusive and fearless classroom environment, social justice, collaboration, and motivation in their classroom teaching.

Training implications. This research has identified several insufficiencies that create injustice for mathematics teachers and students. Mathematics teachers are poorly trained to accomplish ICT integration and address students' diversity in classroom teaching. From this perspective, mathematics educators and trainers can develop a package that can address the gaps identified in this study.

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Appendix – I

Classroom Observation Guidelines

The primary purpose of this classroom observation is to demonstrate how mathematics teachers use pedagogy in the classroom while teaching in a multicultural classroom based on the following constraints:

- Linking the teaching-learning activities with the multicultural context of the students.
- The opportunity of freedom, fairness, equality, equity, and children's culture friendly.
- Promoting multiculturalism in the classroom.
- Knowledge of multicultural competency of the teacher.
- Response to culturally diverse students.
- Whether the examples used by teachers support multiculturalism.
- Decision-making process in the classroom.
- Concluding the issues in the classroom.
- Valuing the student's capacity.
- Using students as a resource of knowledge.
- Using culturally relevant and mathematical artefacts, teaching materials, models.
- Asking questions related to cultural context.
- Starting lessons with examples related to student's cultures.
- Linking mathematics classroom discourse with student's culture.

- Students' engagement, and motivation strategies followed by teachers.

Appendix – II

Interview Guidelines for Students

Student’s Name:

Class:

Position in the Class:

Caste / ethnicity:

Address:

Special religious Culture:

The interview with students can be taken on the following main aspects:

- Problems related to mathematics learning.
- Problems related to classroom language.
- Problems related to multicultural classroom management and engagement.
- Problems related to mathematics learning in a culturally diverse group.
- Problems related to classroom pedagogy.
- Problems related to mathematics (curriculum) textbooks.
- Problems related to teaching materials used in classroom teaching.
- Problems related to evaluation for multicultural students.
- Problems related to child rights.
- Problems related to cultural rights.
- Problems related to math anxiety.

Appendix – III

Interview Guidelines for Teachers.

- Experiences and issues related to teaching mathematics in multicultural classrooms.
- Experiences and issues related to curriculum materials.
- Experiences and issues related to concept formation of mathematics subject.
- Experiences and issues related to student participation.
- Experiences and issues related to the use of local materials.
- Experiences and issues related to centrally prepared curriculum.
- Experiences and issues related to the contextualization of mathematics knowledge.
- Experiences and issues related to delivering the subject matter to the students.
- Experiences and issues related to the selection of mathematics teachers.
- Experiences and issues related to mathematics teaching activities.
- Experiences and issues related to student evaluation.
- Experiences and issues related to classroom teaching language.
- Experiences and issues related to school resources in delivering mathematical knowledge.
- Experiences and issues related to challenges faced by teachers handling the culturally diverse classrooms.

Appendix – IV

Interview Guidelines with Mathematics Educators.

- Nature of mathematics.
- Mathematics for all or mathematics for an exclusive group.
- The relation between mathematics and culture.
- Ways of incorporating local knowledge in school level mathematics.
- Ways of incorporating cultural teaching in mathematics through teacher training.
- Ways of incorporating local/cultural knowledge in the teacher preparation course.
- Ways of incorporating local knowledge in everyday teaching-learning activities.
- Ways of incorporating multicultural knowledge in student evaluation.
- Relevancy of learning theories in multicultural teaching.
- The satisfaction of the mathematics teacher in their profession.
- Provision the ICT-based training and in-service training.

Appendix – VII

Interview Guidelines for Head-teachers.

- Sufficiency of mathematics subject teacher in the school.
- Condition of mathematics teaching in the school.
- Extra effort for mathematics teaching in the school.
- Problems of mathematics teacher training.
- Availability of mathematics teacher.
- The effort of school for cultural training.
- Role of school for motivating mathematics teachers.
- Application of ICT and emerging technologies in mathematics pedagogy.

Appendix – VIII

Dyadic Interview/ FGD guidelines for Teachers

- Problems related to student motivations in learning mathematics.
- Opportunities and challenges related promoting mathematics classroom discourse.
- Problems related to classroom discourse in multicultural classrooms.
- Opportunities and challenges related to student-friendly classroom discourse.
- Problems related to engagement of student in the classrooms.
- Problems related to student participation.
- Problems related to the use of local materials.
- Problems related to centrally prepared curriculum and textbooks.
- Problems related to the contextualization of mathematics knowledge.
- Problems related to delivering the subject matter to the students.
- Problems related to the selection of mathematics teachers.
- Problems related to mathematics teaching activities.
- Problems related to student evaluation.
- Problems related to classroom teaching language.
- Problems related to school resources in delivering mathematical knowledge.
- Problems related to challenges faced by teachers handling the culturally diverse classrooms.

Appendix – IX

Classroom Discourse in Nepalese Schools:

Discussion Guidelines for Teachers

1) Do you have prepared written notes/proper lesson plans before entering the class?
2) Do you use teaching materials during the classroom discourse?
3) Do you prepare plans of activities and questions to ask students to get more output of teaching-learning situations in the classroom discourse?
4) Which factors are more effective for you to conduct the class smoothly in an interesting way?
5) Which are the teaching methods you use in the classroom to have good classroom discourse? What are its purposes?
6) Do you satisfy with the classroom discourse? Why?
7) What are the differences between today and previous classroom discourse? What are they?
8) Do you use one way, two-ways, or multiple ways of communication skills in your classroom?
9) Do you think further learning work helps the students to learn and update for the next class?
10) What reinforcement process is used in classroom teaching?
11) Do you have a regular training program in a school or your school sends teachers for further training?

12) Do you teach in the classroom according to daily, weekly, monthly, and yearly lesson plans?

13) Are you happy with your profession?

14) Do you have any suggestions to improve the school's teaching-learning the situation in a better way?

15) Does your head-teacher supervise classroom-teaching activities? Which way and how often?

16) How do you motivate your students?

17) What types of student engagement skills do you use in the classroom?

Appendix – X

Focus Group Discussion Guidelines for Students

1. Do you enjoy learning mathematics in classroom discourse?
2. Which factors are more effective to you to be interested to participate actively in the classroom discourse?
3. Which are the teaching methods you like the most? Why?
4. Are you satisfied with the classroom discourse? Why?
5. What are the differences did you find between today and previous classroom discourse?
6. Do you find two-way communications as in classroom discourse?
7. List the activities that you like the most during classroom discourse.
8. What activities do you suggest to conduct classroom discourse more effectively?
9. Do you have enough chances to raise questions in the classroom? How is it responded?
10. Are you motivated in the day to day classroom discourse?
11. Are you happy with the day to- day mathematics classroom discourse? Why?
12. Does your head-teacher supervise classroom teaching activities? Which way and how often?
13. Do you find difficulties in content delivery in the classroom discourse?
14. What is the motivational process applied in the classroom?
15. What is the role of students to make the mathematics classroom interesting, student-friendly?
16. How do your mathematics teachers engage students in the classroom?

Appendix – XI

Coding and Thematization Process

Transcribed and language translated Interview

BB: It's my great opportunity to talk with you. Sir, you have already taught more than three decades in community schools in different parts of Nepal. Regarding your experience, what are the key factors to improve the existing pedagogy in Nepalese classrooms?

***Educationist**:*

Teachers are the epicenter of creation, interpretation, implementation, and transformation of classroom pedagogy. In Nepal, school, as well as classroom cultures, need to be reformed through rules and regulations. When the teacher spends more time on the student teaching, the student can learn more, but when the teacher cannot provide the student enough time, the student learns less. Most schools in Nepal only use teaching methods that are no longer sufficient today. Pedagogical culture needs to change or be replaced by new ones. Today's students expect more from their teachers and schools too. Teaching methods should take into account both theory and practice while taking into account the social and cultural foundations of related fields and cross-cultural practice. This activity forms the foundation and sustainability of the classroom teaching process. Effective learning requires demonstration, group discussion methods, role-playing, and problem-solving. But all these skills must be well-practiced, student-centered, student-friendly, and should be practiced in a small group of students. Another factor also affects the quality of education and these are social, cultural, and economic factors. In many parts of Nepal, teachers are not very interested in teaching children in a normal school environment because of insufficient infrastructure. The teachers follow the traditional classroom pedagogy and no longer show any interest in the modern schooling system. Although children go to school, they are busy *with traditional activities at home, making it difficult for them to learn. Many parents have low purchasing power, so students do not get an opportunity of purchasing more reading and writing materials. These are some of the factors that affect the quality of education in Nepal. The quality of school education depends on curriculum, education planning, school administrators, headmasters, teachers, etc. To create a suitable learning environment, schools must have good equipment. There must be libraries, practical laboratories, furniture, clean drinking water, separate toilets for boys and girls with enough water, extracurricular activities, and a healthy environment in institutions. The number of students in the class should be limited to avoid crowds and noise. Teacher management plays an equal role in improving the quality of education. A qualified teacher can teach students effectively without frightening them. Schools should not be centralized, but autonomous to operate effectively under the existing environment, socio-geographical situations, and existing infrastructure. …. They must be handed to the community, and a management committee must be fully responsible for the operation of the school, with well-trained teachers and financial responsibilities.*

CODING AND THEMATIZATION PROCESS

Interview Contents	Generating Initial Codes	Searching for Themes	Reviewing Themes
Teachers are the epicenter of the creation, interpretation, implementation, and transformation of classroom Pedagogy. *In Nepal, school, as well as classroom cultures, need to be reformed through rules and regulations.* *When the teacher spends more time on the student teaching, the student can learn more, but when the teacher cannot provide the student enough time, the student learns less.*	*Empowering Teacher* *Classroom culture reformation* *Teaching time matters*	*Pedagogy improvement/ transformation* *Improve Teachers' Responsibility* *Socio-cultural setting*	*Radical Transformation in the education system is necessary*

Most schools in Nepal only use teaching methods that are no longer sufficient today. Pedagogical culture needs to change or be replaced by new ones.	*Reformation of pedagogies*		
Today's students expect more from their teachers and schools too. Teaching methods should take into account both theory and practice while taking into account the social and cultural foundations of related fields and cross-cultural practice.	*The advocation of practical education*	*Infrastructure improvement*	
This activity forms the foundation and sustainability of the classroom teaching process. Effective learning requires demonstration, group discussion methods, role-playing, and problem-solving.	*Multimethod Pedagogy*	*Provision of Practical education in small groups*	
But all these skills must be well-practiced, student-centered, student-friendly, and should be practiced in a small group of students.	*Student-friendly pedagogy*		
Another factor also affects the quality of education and these are social, cultural, and economic factors.	*Socio-cultural factors matter*		
In many parts of Nepal, teachers are not very interested in teaching children in a normal school environment because of insufficient infrastructure.	*Low-level infrastructure*		
The teachers follow the traditional classroom pedagogy and no longer show any interest in the modern schooling system.	*Traditional Pedagogy*		
Although children go to school, they are busy with traditional activities at home, making it difficult for them to learn.			
Many parents have low purchasing power, so students do not get an opportunity of purchasing more reading and writing materials. These are	*Insufficient time at home*		

some of the factors that affect the quality of education in Nepal.	*Poverty*		
The quality of school education depends on curriculum, education planning, school administrators, headmasters, teachers, etc.	*Education system matters*		
To create a suitable learning environment, schools must have good equipment.	*Infrastructure Matters*		
There must be libraries, practical laboratories, furniture, clean drinking water, separate toilets for boys and girls with enough water, extracurricular activities, and a healthy environment in institutions.	*Infrastructure Matters*		
The number of students in the class should be limited to avoid crowds and noise.	*Number of student matters*		
Teacher management plays an equal role in improving the quality of education.			
A qualified teacher can teach students effectively without frightening them.	*Qualification of teachers matters*		
Schools should not be centralized, but autonomous to operate effectively under the existing environment, socio-geographical situations, and existing infrastructure.	*School transformation*		
They must be handed to the community, and a management committee must be fully responsible for the operation of the school, with well-trained teachers and financial responsibilities	*Qualified and responsible manpower*		