BECOMING AN EMPOWERING MATHEMATICS PEDAGOGUE THROUGH STEAM EDUCATION APPROACHES: AN AUTOETHNOGRAPHIC INQUIRY

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AN ABSTRACT

of the dissertation of *Tamlal Khanal* for the degree of *Master of Philosophy in STEAM Education* presented on *20 January 2025* entitled *Becoming an Empowering Mathematics Pedagogue Through STEAM Education Approaches: An Autoethnographic Inquiry.*

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Asst. Prof. Indra Mani Shrestha

Dissertation Supervisor

From my long period of teaching experience as a mathematics teacher/lecturer, I found that most of the students are not satisfied with mathematics and mathematics-related disciplines because the learning process is considered as the disciplinary knowledge transmitter from the teacher's heads to the student's means that (we) teacher do not act as our context as required. However, we have been guided through a conventional rather than a growth mindset in our teaching and learning process. For example, *practice makes a student perfect; be aware of this final exam question*! etc. The monotonous teaching in the classroom and the rigid ways of teaching hampers the creative ways of the learning process. Our teaching tendency at our lower grades (school) is embedded as in the university in the context of pedagogy (Lecture Method). Hence, I focused on accessing and empowering mathematics teaching-learning activities by enhancing learners' foundation through different pedagogical practices. Those experiences of teaching and learning inside and outside of the classrooms presented as the transmitter teacher gave them only the theoretical knowledge in a controlled class environment. From the eye of an autoethnographer, I have primarily selected two avenues to approach the research goal of conventional/empowering pedagogues through different social settings.

For the balance of conventional and empowering pedagogue (me), the emerging discourse of STEAM as a multidisciplinary/transdisciplinary approach in

pedagogical practice intuited me to pause and reflect on my pedagogical journey. Further, I realized that the cause of the difficulty in mathematics is a lack of prior mathematical knowledge. So, by applying STEAM projects in the classroom, I considered the condition that the students have basic mathematical skills while teaching mathematics. The STEAM approach is a multidisciplinary learning approach that supports the emergence of new knowledge and learning with the attachment of different disciplines inside the same world and a hands-on innovation process. Critical constructivist thought is too important for the innovation process in this research because it helped in many critical aspects of my research. This approach helps students develop mathematical skills and abilities necessary for success in a rapidly evolving, interdisciplinary world.

After unpacking and critically reflecting on the various events and incidents of my pedagogical journey so far, I have tried to come up with some possible improvements in my/our pedagogies towards a pragmatic way in mathematics. The major significance of this research is to improve the mathematics classroom through the emerging pedagogies in a synergetic way or by emphasizing the holistic meaning-making process (STEAM). Also, this study assists the teachers, experts, curriculum planners, and policymakers in understanding the existing situation and practices of social justice in mathematics classrooms. It gives insights for transforming teaching methods, reforming curriculum, and promoting democratic justice in the classroom. The ultimate goal of my research was to empower the learner through transformative pedagogy in the mathematics classroom. To achieve the transformative goal, I also critically evaluated my deep-rooted beliefs.

…… 20 January 2025

Tamlal Khanal

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शोध सार

स्टिम शिक्षामा दर्शनशास्त्रको स्नातकोत्तर डिग्रीको लागि टामलाल खनालको शोध प्रबन्धको शीर्षक "स्टिम विधिबाट गणित शिक्षक सशक्त बन्दै : एक आत्मवित्रात्मक अनुसन्धान" ७ माघ २०८१ मा प्रस्तुत गरिएको थियो।

.....

उप. प्रा. इन्द्र मणि श्रेष्ठ

शोध निर्देशक

म एउटा गणित शिक्षक हुदै प्रँध्यापकको रुपमा लामो समय कामगर्दै गर्दा गणित तथा गणित सम्बन्धि बिषयहरुमा विद्यार्थिहरु सिक्ने र सिकाउने प्रकृया संग सन्तुष्ट भएको भेट्न सकिन, किनभने शिक्षण गर्नु भनेको जुन ज्ञान शिक्षकको मस्तिष्कमा छ, त्यही ज्ञान विद्यार्थिहरुमा पुर्‌याउन सके पुग्छ भन्ने कुरा जोड दिईयो । साथै शिक्षण सिकाई सन्दर्भहरु समयानुकुल बनाउन खोजेनौ । यद्यपि हाम्रो शिक्षण सिकाई प्रकृया परम्परागत शिक्षण विधिहरु, जस्तैः व्याख्याबाट नै निर्देशित छौ । जवकी, आधुनिक विधिहरुबाट टाढा छौ । जस्तै,'' धेरै अभ्यासले विद्यार्थीहरुलाई पोख्त बनाउछ''। ''ख्याँल गर है यो तिम्रो अन्तिम परिक्षामा शोधेको प्रश्न हो'' आदी। यि कथनको आशय भनेको सिकाई भनेकै रट्नु हो । कक्षाकोठामा निरस शिक्षण र कठोर शिक्षण विधि प्रयोगको तरिकाले सिर्जनात्मक सिकाईमा बाधा पूर्‌याउछ । अहिले पनि हाम्रा स्कुलतहका शिक्षण विधिहरु विश्वविद्यालय तहका विद्यार्थीहरुलाई पढाउने व्याख्यान विधिसंग मिल्दाजुल्दा नै छन् । तसर्थ मेरो ध्यानमा परम्परागत शिक्षण सिकाईलाई जोड्दै नवित्तम शैक्षिक विधिहरु मार्फत गणितलाई अनुसन्धनात्मक तथा प्रायोगात्मक बनाउन सकिन्छ कि भन्नेमा भयो । अझै, जो परम्परागत शिक्षण शैलि अपनाएका शिक्षक हुनुहुन्छ उहाहरुलाइर् धेरै शैद्धान्तिक साथै नियन्त्रित कक्षाको वातावरणमा ध्यान दिईएको भेटियो । त्यसैले अटोईथ्नोग्राफरको दृष्टिले हेर्दा मेरो अनुसन्धानको उद्देश्य प्राप्त गर्न परम्परागत तथा नविनत्तम् शिक्षण विधि अपनाए शिक्षकका मार्गहरु प्राथमिकमा राखेको छु । यस अनुसन्धानमा परम्परागत र नविनत्तम सिकाई विधिमा प्रयोग गर्ने शिक्षकका शिक्षण विधिका यात्रालाई हेरिएको छ । यसबाट मलाई के अनुभव गराएको छ भने गणित सिक्न गणितसिपका पुर्व ज्ञान एकदमै आवश्यक पर्दछ । जहाँ गणित कक्षामा स्टिम प्रोजेक्टको प्रयोग गरि शिक्षण गर्न सकेमा विद्यार्थीका ज्ञान तथा सिपको दिगो विकास गर्न सकिन्छ । किनकी स्टिम विधि भनेको बहुविद्यात्मक सिकाई विधि हो । जहाँ विद्यार्थीहरुमा एउटा बिषयको मात्र ज्ञान नभई विभिन्न बिषयहरुको ज्ञानलाई जोड्ने गर्दछ भने बहुविद्यात्मक सिकाईले नयाँ नयाँ खोज तथा ज्ञानको वृद्धि गर्नमा मद्दत गर्दछ । जसले विद्यार्थीहरुको कक्षाकोठामा सिकाईको सकारात्मक आलोचनाको विकास गर्दछ । मैले गणितलाई प्रयोगात्मकतमा जोड दिनको लागि मेरो गणितशिक्षण सिकाईको लामो अनुभवको यात्रालाई आलोचनात्मक ढँगबाट विभिन्न घटना तथा परिघटनालाई

जस्ताको तस्तै उतारेको छु । यस अनुसन्धानको प्रमुख उद्देश्य भनेको अर्मुत गणितलाई स्टिम प्रोजेक्टको प्रयोगद्वारा प्रयोगात्मक गणितमा जोड दिंदै विद्यार्थीको गणितीय ज्ञानसिपको समग्र दायरा बढाउनु हो । यसका अरु उद्देश्यहरुमा शिक्षक, विज्ञ, पाठ्यक्रमका योजनाकारहरु साथै निर्माताहरुलाई अहिलेको शिक्षण विधिको अवस्था र भावि योजनाका बारेमा बुझाउनु हो । जसले गर्दा शिक्षण विधि तथा पाठ्यक्रमलाई समयानुकूल सुर्धानमापनि सहयोग पुर्याउनु हो ।

..... ७ माघ २०८१

टामलाल खनाल

उपाधि उम्मेदवार

This dissertation entitled *Becoming an Empowering Mathematics Pedagogue Through, STEAM Education Approaches: An Autoethnographic Inquiry* presented by *Tamlal Khanal* on *20 January 2025.*

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

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Tamlal Khanal
Degree Candidate

DECLARATION

I hereby declare that this dissertation is my original work, and it has not been submitted for candidature for any other degree at any other university.

……. 20 January 2025

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Degree Candidate

DEDICATION

This dissertation is solely dedicated to my mother, who always stood up for my education, and because of her I am here at this brighter phase of education.

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Finally, I am thankful to my better half, Bishnu Maya, for her enduring support and care, and to my son Birat and daughter Bigyanshi, for creating a pleasant and homely environment during my research study.

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CHAPTER I
GERMINATION OF RESEARCH AGENDA

In this chapter, I present my pedagogical observations as a student and a teacher, especially regarding mathematics pedagogies. By presenting different circumstances of my teaching and learning journey to date, I critically reflected on my existing pedagogical practices, curriculum, and common beliefs about mathematics. Then, I present how I learned the integrated pedagogical approach (STEAM) in the educational sector and conceived transformative pedagogical practices through the emerging STEAM approach. At the start of the chapter, with positioning, I problematized the situation by presenting the purpose of a research study with my research questions.

I begin the chapter with events and incidents to position myself in research inquiry. There, I have introduced myself and presented the reasons that demystify carrying out this research agenda. For this purpose, I portrayed what I had/have been experiencing as a learner from school level to university and how I have been teaching. Also, I demonstrated my situation and how the STEAM approach helped to transform my deep-rooted beliefs and practices in mathematics education.

Background of the Research Study

We have deep and different perceptions (good/bad) about mathematics in our society, such as mathematics being a complex subject, mathematics being a subject for brilliant students, and mathematics being designed as a manly domain subject (Belbase, 2013). As a result, those with low performance in mathematics subjects do not prefer mathematics and mathematics-related activities because the learning procedures promote the collection of universally accepted mathematical truths as a body of pure knowledge rather than contextual learning procedures (Luitel, 2013). Nepali, English, Social Studies, and other subjects can be explored by connecting their everyday real-world practices. On the contrary, mathematics is a very complicated subject as a foreign subject like English (Luitel & Taylor, 2005) because mathematics textbooks do not have stories, poems, and drama to create a mathematical mental image in mind as in other subjects.

Mathematics is taken as a different and isolated subject; it cannot address real-life situations of the individual, but still, our learners are suffering from such deep-

rooted anxiety. Among these various observations of mathematics, the maximum number of individuals share their disagreeable understandings and perceptions (Belbase, 2013). Most of us used to ask a question similar to the mathematics teacher's: "Where do we use algebra in our daily life, sir?" It seems to be simple but is an unanswerable question for us because our teaching-learning approaches are too conventional, meaning that we could not relate our subject matter with our daily context or real situations in the classroom through different pedagogical practices to the algebraic expression from the beginning of the classes. Those are the many factors that boost the student's anxiety in mathematics.

The demand for 21st-century skills may result from technical, economic, and social transformations and in response to a quickly changing world and new encounters. If we empower our learners through the holistic meaning-making process collating Science, Technology, Engineering, Arts, and Mathematics (STEAM), that will help to promote engagement in learning, real-world problem solving, planetary conscious citizens, and many more contexts. As Lin et al. (2021) state, practical and hands-on learning are essential components of STEM, such as problem-solving and inquiry-based learning.

My Personal Experiences as a Student

I still remember some incidents of my schoolteachers, about 25 years ago, teaching me mathematics in grade six additions, subtraction, and multiplication of simple algebraic functions. But they taught me algebra using the question answer technique with their active engagement rather than activating the students (us). He used to ask us several questions, and we were required to give readymade answers such as $x \cdot x = x^2, x^2 \cdot x = x^3$ …., and so, instead of involving us in meaning-making with learning the situation as my teacher did. For example, the teachers would have engaged us in conceptualizing x, x^2, x^3 etc., using diagrams and solid materials. They would have helped us to conceptualize that x represents the length of the line segment, x^2 represents the volume of a cube, etc.

In algebra and the features of geometric figures, we followed the rote-memorization method. We followed the rote-memorization method not only in algebra but also in the features of geometric figures. Furthermore, the teacher gave us rules and readymade answers to the textbook questions, which we were supposed to learn by rote within a given time. For example, I still remember when my

mathematics teacher asked me to draw a rhombus and write two properties about the rhombus on the blackboard. However, I couldn't draw that precisely because I had not been exposed to that figure before from the teacher's side or elsewhere, and my teacher punished me. Though this kind of exposure provided us with mental training, it couldn't make us read, re-read, reason, and reproduce the subject matter. As a result, rote memorization was more important than interaction and knowledge creation in the teaching and learning process.

Similarly, in 2008 AD, I joined an MA in Mathematics with hope and energy, but due to my school responsibilities as a teacher, I could not join the class on time. I remember that it was 16th April 2009 when I came to Kathmandu from Butwal. The next day, I went to college and knew nearly thirty percent of the first year's course was completed. I felt nervous and entered my first class; it was 10 AM. After a few minutes, Ram (Pseudo name) sir came into our class and started to write a theorem of algebra subject in a topic of *Group, Ring, and Field.* Primarily, the theorem was related to Group. He had written the first and the second pages from his old notebook when he was on the last page of that theorem. No one was asking questions about the theorem because, as our old batch brothers had told us, you could not write in the examination without reading yourself, so there was no worth commenting on his other lecturers. However, I tried to ask a question to Ram sir. Sir, how can we know this theorem? Still, I could not understand one line as well. Sir looked after me and asked, "*Is this your first-day bhai (brother)?"* I told him, yes, sir, this is my first day. *"So that you become unknown."* He added that *to get good marks in mathematics, you should have to chant the important theorem, which is frequently asked in TU exams. You need an excellent mind to memorize all formulas precisely the same. And need to practice them again and again. You need not be creative. Take care otherwise….*

I sat in a miserable condition in the classroom because I thought there would be well-experienced Ph.D. teachers and professors in their related fields, and I would get a good opportunity to understand mathematics and its real-world applications, too. When he left the class, I introduced myself to some friends and asked them about the nature of mathematics. They also suggested that we memorize the important theorem and leave to ask the questions in the classroom. Henceforth, I tried to adopt the same, but it was not as easy for me as my friends would. Anyway, I graduated after two

years, and now I have lost all those theorems and definitions I memorized during my studies.

My learning process was too rigorous and painful due to the knowledge transmission process. That was the major disempowering factor for me, and I hardly experienced different dimensions of learning, such as affective, cognitive, and somatic (experiential learning). Moreover, as Belbase (2013), mathematics is taken as a different and isolated subject; it cannot address real-life situations of the individual, and yet we are suffering from such deep-rooted anxiety about mathematics that has been gradually taking students away from learning mathematics meaningfully. Most of us used to ask a question similar to the mathematics teacher's: “Where do we use algebra in our daily life, sir?” and so on. It is always an unanswerable question because our teaching and learning approaches are too conventional. Hence, we could not relate our subject matter to our daily contexts and real-world situations in the classroom through different pedagogical practices. So, I tried to explore my pedagogical practices to portray my stories of becoming an empowering mathematics pedagogue through the STEAM education approach.

My Personal Experiences as a Teacher

After completing my intermediate level, I was selected as a pre-primary mathematics teacher in 2002. At that time, I had faced many obstacles inside the classroom. There was no necessary trend of recruiting female mathematics teachers in preprimary classes. So, I was selected as a pre-primary mathematics tutor in a Private institutional School. When I entered a preprimary class (Grade -2) as a mathematics teacher in the middle of the session, I found that some of the topics were already completed. I asked the children questions about the simple number system, but approximately ninety percent of the students could not answer them. After that, I revised those topics for a week and started a new topic with some related concepts. After a week, I took a test on that topic, but about fifty percent of the students failed. On the result day of the class test, I badly punished those who failed. Still, I remember always saying to them, "I need marks whatever you do." I continuously taught them similarly for a week and took a class test. However, the position of the students was the same. On the result day, I distributed their answer sheets but did not charge any punishment because that made me think and rethink my instructional activities. I counseled them about mathematics learning methods at the end of my class.

Then, that result made me feel about their result, and I asked my roommate, a mathematics teacher at a so-called renowned school. In the evening, we discussed that problem and concluded that those students need to learn the fundamental *concepts of mathematics*. He also told me that he had been facing the same problem in his classroom. But I could not get a satisfactory answer, and then the next day, I kindly asked the students, "Why could you not do well in this mathematics examination? Or, you did not know my teaching method?" At the same time, one student told me, "*No, sir, you are right. We try to memorize mathematics but cannot remember, sir*." Their innocent voice touched my heart. Then, I changed my teaching method, methodology, and technique in the classroom as I knew and got a significant change in the result. Similarly, I faced the same problem in lower-secondary and secondary-level mathematics classes. However, in the secondary-level mathematics class, I found that democratic and collaborative pedagogies help learners be proactive, imaginative, and real-life problem solvers. Also, a democratic classroom promotes ethical responsibility with a more participative, supportive, and opportunity-based approach inside the classroom (Dewey, 1923**).** So, I intend to assist the learner in the mathematics classroom through this research using the STEAM approach. From my twenty years of teaching experiences from nursery to master program, pedagogy/approach is a major factor in empowering the learner inside the mathematics classroom with deep and meaningful engagement towards the issues. Hence, this inquiry seeks to develop empowering mathematics through the dynamic and emergent pedagogical approach focusing on the learner's holistic development.

Those were the days of January 2020 when we, two block mode students, reached Kathmandu University premises at Hattiban, Lalitpur, as students of STEAM education. We spent nearly a week on our MPhil study. We mainly took classes with Bal Chandra Luitel sir and Binod Pant sir. After a week, we returned home with our assignments in different subjects. Unfortunately, the next schedule of our regular class was dismissed due to COVID-19. So, we were obliged to read at home in the online medium. We enjoyed a lot on that platform as well. Most of the project tasks we performed as given in the syllabus, such as artistic collaboration task teaching coordinate geometry, art-based pedagogies on mathematics teaching, TED talk narrative method on teaching, and so on.

Among them, I preferred one method, the art-based pedagogy, to understand the situation of mathematics, even complex problem-solving in engineering

mathematics. That made me think and rethink the different pedagogical practices, especially STEAM-based pedagogy. In the era of compartmentalized pedagogical practices, this method is too progressive to create the understanding level of our students, as I have practiced in my class, such as **"*How to find the area of the irregular plot (by using integration method)?"***

Learning Outcomes:

1. Students can select the respective limits by fixing the Centre of that irregular plot.
2. Students will be able to trace upper curve and lower curve concepts.
3. Students will be able to put those limits as required as the question
4. Students can select the surface of an irregular plot/ field.

Time: It may take approximately one hour to deliver the concept.

Materials: Especially cardboard, different colors of threats, glue sticks to attach threats, scissors, and scales.

Form of Art used in this learning:

In this learning process, I am trying to incorporate the idea of "Art *as a storytelling method"* because that story may motivate them to be active and curious about the problem. Through this storytelling, learners can easily assimilate that problem and help to cope with the situation.

Theoretical Perspective:

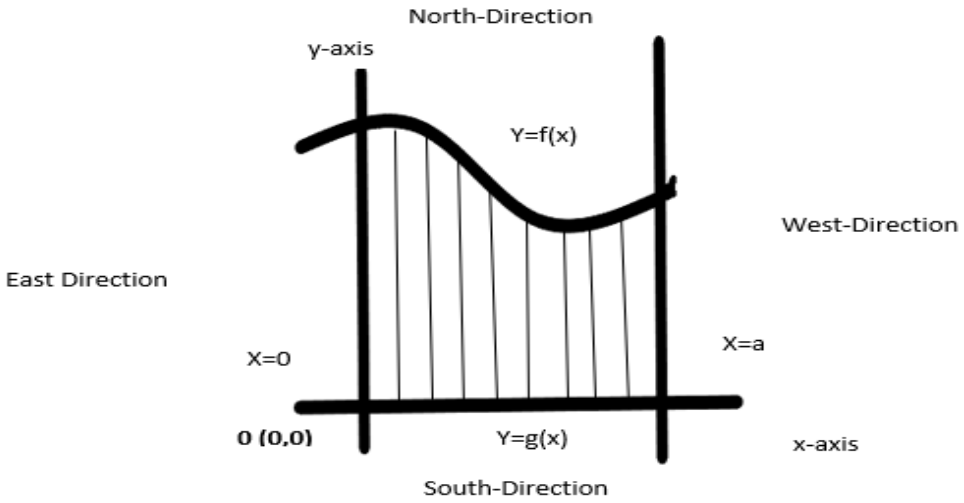
In this context, *social constructivism theory* is relevant because it emphasizes the importance of culture and context in understanding societal events and creating knowledge based on that understanding. Mathematics learning is also a socializing process. Mathematics is present in every cultural activity. So, we learn the major abstract form of mathematics from our culture and society. For instance, to deliver the concepts of numbers to the child, we must show the rigid objects from his surroundings rather than direct rote recall. As my today topic for class eleven mathematics is finding the area of a plot under the curve, I am trying to assimilate this topic as our social issue of land because this type of social context/situation helps them perceive and solve the problem of mathematics. Hence, social constructivism may be a good theoretical lance in my study.

Details of activities: I have selected the storytelling method to deliver abstract ideas about the application of integration. That will help the learner to consolidate their ideas about the given topic. To make a solid concept of the following figure, I tell a story to them and continue my activities; a clever land broker has a big plot of field.

However, he was unaware of the area of his field/plot. One day, he thought about identifying the area of his field. He tried to find the area himself, but he could not do it because it was not regular in shape, and he called the surveyor to find the area of his field. The surveyor asked for the details of his plot, and the broker said that *"there is 20 ft road in the east, drainage pipe in the west, Alka hospital in the north and public school in the south"*. Hence, the surveyor found that.

Figure 1

Integration Model



Upper boundary (upper curve) = Public School, y = f(x)

Lower boundary (lower curve) = Alka Hospital, y = g(x)

East boundary = 20 ft road, x = 0, origin

West boundary = drainage pipe, x = a, straight line.

The cleaver land broker was watching the engineer's idea. The surveyor found that the calculated area of the irregular shape figure is: east boundary to west boundary and upper boundary minus lower boundary (in Nepali, we say that Charkilla) i.e., $\int_{east\ boundary}^{west\ boundary}(Upper\ boundary\ -\ Lower\ boundary) = \int_0^a [f(x) - g(x)]$ dx is the required red area bounded from four sides, Where dx is the limit of the x-axis. At last, he learned that idea as well.

Assessment activities: Generally, there are two types of questions, limited to the x-axis or the y-axis. For numerically different assignments, those two questions may be asked, and the figure is compulsory to know the exact area of the plot. So, a figure is necessary. So, the assessment rubric may be constructed as,

Questions	Drawing	Fixing limits	Process	Remarks
Different two questions	Max. 15%	Max. 15%	20%	Total- 50%

When I got an opportunity to enroll in Kathmandu University for my MPhil, in the STEAM education program, my belief systems were challenged, and I envisioned the STEAM approach to displace the "chalk and talk" pedagogy and embrace new scientific methods as student-centric, collaborative, and inquiry-based learning pedagogies. My learning journey as a STEAM scholar has helped me learn about the importance of this multidisciplinary approach in pedagogical practices. So, a unified curriculum (STEAM) aims to assist students in changing their learning performance and engagement and prepare graduates for real-world problem-solving challenges (Boy, 2013).

I realized from my long learning and teaching journey that the conventional (largely, subject-centric pedagogy) way of teaching promotes learners' anxieties and deprives their hidden skills. In this regard, I have decided to conduct a research study on critically re/examining or reflecting on my conventional/progressive teaching pedagogies. Through the emerging STEAM approach, I am trying to transform from a conventional mathematics pedagogue to a progressive (empowering) mathematics pedagogue.

Problem Statement

Based on my experience as a student and teacher of Mathematics to bachelor, intermediate, and school-level students for 20 years, I found that most of the students are not satisfied with mathematics and mathematics-related disciplines because the learning process is considered as the disciplinary knowledge transmitter from teacher’s heads to student’s (Luitel & Taylor, 2003) means that (we) teacher do not act as our context as required. Still, we have been guided through a conventional rather than a growth mindset. Our teaching tendency at the university (conventional means more theory-driven) is also embedded in our lower grades. Hence, I focus on accessing and empowering mathematics teaching-learning activities by enhancing learners' foundation through different pedagogical practices. Furthermore, when learning takes a pragmatic form, then learning becomes worthwhile either in mathematics or science and social holistically.

In my MPhil research, I have consolidated my experiences and how I have been using empowering pedagogy in the mathematics classroom, which is a dialogic,

democratic, and collaborative STEAM (Science, Technology, Engineering, Art, and Mathematics) approach to help on the foundation of the subject matter. Dialog pedagogy helps learners enhance sustainable learning instead of a mechanistic classroom culture. The main purpose of including democracy in the classroom is to empower the students to learn about the multiple perspectives of controversial issues. In the democratic classroom, students engaged in a collaborative learning approach. Collaborative learning develops learners' creativity and focuses on collaboration, verbal and non-verbal communication, problem-solving, and critical thinking (Bruce et al., 2016). The current teaching tendency is mainly the teacher-centered method in a mathematics classroom in our context. This research will assist me in teaching and learning using different pedagogical approaches and making a vision for emergent STEAM pedagogies.

Hence, my attention is on the following: Why do learners dislike learning mathematics? Is the teacher-centered method always the best method for mathematics classrooms? Why is mathematics always a burden to students in school, college, and university? How can it be a favorite subject for students? Such pertinent issues always touch my heart and mind about this research agenda. So, my research agenda germinated in different situations, such as a one-size-fits-all approach in the mathematics classroom (Luitel, 2009). Kafle's (2022) report on the CDC of Nepal shows that child-centered pedagogy is still hindered in Nepal. That means most teachers un/knowingly do not use suitable pedagogical methods. That assists the one-size-fits-all approach, which means that whatever teacher does a correct mathematics problem, and the answers are non-questionable, the rote-recall method is largely suitable for obtaining good marks. The above condition justifies that this research is relevant for the context of Nepal in the mathematics classroom.

Also, the other dangerous element of such scenarios is our deeply seated beliefs, practices, and ideologies of students, teachers, schools, and communities towards mathematics. Hence, this research helped me to prove my pedagogical practices through the process of critical reflection.

Purpose of the Study

The purpose of my research study was to investigate my approaches to teaching mathematics as a conventional mathematics pedagogue and an empowering mathematics pedagogue within STEAM education approaches.

Research Questions

1. How did I teach mathematics as a conventional pedagogue?
2. How have I been becoming an empowering mathematics pedagogue through STEAM education approaches?

Rationale of the Study

Mainly, this research helped me to cultivate knowledge about the pedagogical uses and shifts for the betterment of the mathematical classroom. This research is expected to provide vision and encouragement to teachers and students to facilitate different curricular activities to frame mathematics in various dimensions. It will also support changing mathematical beliefs, assumptions, and perceptions as necessary in mathematics. Primarily, this research will help shift the pedagogical system and make me aware of the pedagogical use in the mathematics classroom. Furthermore, in the current context of Nepal's fragmented (compartmentalized) subject learning system with compartmentalized pedagogies, this research will help the math/science teachers generate innovative and holistic meaning-making pedagogies. The major significance of this research is to improve the mathematics classroom through the emerging pedagogies in a synergetic way or by emphasizing the holistic meaning-making process (STEAM).

Chapter Summary

In this chapter, I have tried to knit my all experiences through the different approaches using notes, stories and quotations etc. By presenting my different circumstances of my teaching and learning journey to date. In this section I critically reflected my existing pedagogy and my deep-seated beliefs about mathematics. Generally, problematized the problem tried to pave the situation sequentially such as where we use algebra in our daily life sir? Why we are reading useless mathematics? Such types of pertinent issues are the basis of this chapter. As well as I begin the chapter with events and incidents to position myself in research inquiry. There, I have introduced myself and presented the reasons that demystify carrying out this research agenda. For this purpose, I portrayed what I had/have been experiencing as a learner from school level to university and how I have been teaching. Also, I demonstrated my situation and how the STEAM approach helped to transform my deep-rooted beliefs and practices in mathematics education.

CHAPTER II
LITERATURE REVIEW

The literature review is a widespread summary of previous research on a topic. The essence of this writing is to convey to the reader the ideas and knowledge established on the topic. The literature review relates a study to a larger continuing dialogue in the literature about a topic, filling in gaps and extending previous studies. The literature review can be recognized as the integrative summary of broad themes, theories, experiences, existing policies, and practices in the research topic.

STEAM Education

STEAM education means the synergetic learning process between subjects such as Science, Technology, Engineering, the Arts, and Mathematics. The educational context of STEAM probably explains the nature of the relationship between content, disciplines, interdisciplinary and multidisciplinary teaching methods, problem-based research and inquiry, and lifelong learning traditions of total transformation and sustainability (Richard & Biffle, 2016). STEAM education helps the learner to achieve transversal skills. These skills are increasingly in high demand for learners to effectively adjust to change and to construct eloquent and fruitful lifestyles (critical and innovative thinking, teamwork, communication, etc.). So, STEAM education is a holistic approach to learning. That allows the learner to learn through different artistic ways (rather conventional) by collaborating on different knowledge as different subject matter. Also, the STEAM approach encourages students to find other ways to perceive problems, form their core understanding of subject matters, and apply it to update their knowledge and skills (Pant et al., 2020).

STEAM Education Approach

The quest for empowering pedagogy (STEAM Education Approach) in the mathematics classroom is to empower the learner inside the mathematics classroom by opening up learning and making it more accessible, flexible, and more meaningful using collaborative sharing networks in linked disciplines of study. The emerging pedagogies in this research aim to assist the learner in the holistic meaning-making process using *an inquiry-based learning approach, project-based learning approach, design thinking approach, art-based pedagogy approach,* etc. In my opinion, there is a keen relation between curriculum and the pedagogies used in the classroom. However,

we could not do so well here because our teaching-learning tendency at secondary and higher education levels is promoted by compartmentalized learning as a curriculum as our deep-seated frame of structural references of thinking, beliefs, and actions (Taylor, 2017). To escape from those conventional thinking and learning approaches, I envision constructing the inquiry-based, project-based, art-based, and design-thinking STEAM pedagogy. That will help my research participants and me to see the changes in world view. The STEAM model (approach) for learning is aligned in this research with the vision of a real-life problem solver as a vehicle to generate complete and meaningful experiences (Boy, 2013). So, emergent pedagogy will be helpful in this research agenda. Hence, this approach assists the learner in learning educational concepts using interdisciplinary, situational experience, cooperation, practice, and innovation with its core features (Gao et al., 2020). So, STEAM education aims to develop creative problem-solving skills in interdisciplinary settings, move beyond the individual, and democratically embrace dialogic and collaborative action (Costantino, 2011).

Empowering Pedagogical Approaches

Indeed, the context of our classroom is multilingual, multicultural, and a variety of ethnicities. We act differently in society based on our nature. So, our teaching and learning outcomes may depend upon our culture and beliefs. Hence, tackling our granted assumptions and thoughts can be alleviated by watching our practices (critical reflective practice). Now, it can be obtained in teaching and learning in a democratic and collaborative context. Democracy is taken as the purpose of self and social empowerment, which assists in respecting individual freedom and social justice.

Furthermore, this is the way of conceptualizing teaching and also taking that teacher as a transformative intellectual (Giroax & Laren, 1986). Hence, the democratic classroom promotes an ethical responsibility with a more participative, supportive, and opportunity-based approach inside the classroom (Dewey, 1923). Similarly, collaboration means grouping or pairing learners to achieve learning goals. Hence, I agree with Scott (2015) that collaborative learning is an educational approach that assists the learner in working with peers, exchanging their opinions, questioning others, seeking clarification, and contributing to higher-order thinking such as handling, forming critical analysis, problem-solving, and construction of new learning with a profound understanding of the phenomena. So, those elements are the

relevant catalyst to the extent of the empowering classroom. So, I plan to include democratic and collaborative elements in this research agenda.

Empowering Mathematics Pedagogue

A pedagogue is a teacher or instructor who sometimes can become narrow-minded in his or her approach. However, this type of approach is insufficient in this research because it will try to think outside of the box of the set of pedagogy. So, the discourse of empowering mathematics pedagogues will be introduced. Empowering mathematics pedagogues is to perform as an artist, storyteller, designer, helper, etc., as my research agenda. Ultimately, the learner will work with peers, exchange their views, question others, pursue clarification, and participate in higher-order thinking such as handling, forming critical analysis, problem-solving, and creating innovative learning with a profound understanding of the phenomena (Scott, 2015). Hence, an empowering pedagogue is a classroom model and an artist of the classroom because he may change his art as he desires.

Project-Based Learning

Project-based education is a student-centric learning approach. Largely, it is guided by three constructivist principles: learning in a specific context, learners are actively involved, and knowledge is constructed through the socializing process (interaction and understanding) (Kokotsaki et al., 2016). Through this learning process, learners get more chances to construct knowledge by involving themselves in a real-world problem. This is too important in my research because Project-based learning is correlated to STEM (Science, Technology, Engineering, and Mathematics) curriculum directed to gain in terms of pleasure, engagement with the project, and the skill to combine theory and practice outstandingly (Lou et al., 2011, as cited in Kokotsaki et al., 2016).

Design Thinking Method

Design thinking pedagogy is the most prominent pedagogy for the 21st-century context**.** Design thinking is a reiterative process. It may frequently change and take place. The major purpose of design thinking in education is to cultivate innovative ideas in the classroom. Respectable design thinking skills may support in solving complex difficulties as well as moving to unexpected variations. The design process encompasses 'in-depth cognitive procedures, which may help our students to build their critical thinking skills' (Razzouk & Shute, 2012, p. 343).

Moreover, the design thinking methodology creates a problem-solving framework to manage experiments and derive the best solutions. A short form of the design thinking process can be expressed in five stages: empathize, define, ideate, prototype, and test (Razzouk & Shute, 2012). The first stage of design thinking is empathy. Empathy is the basis of human-centered design and a necessary starting point for all design work. The second stage is the definition mode, where designers use the insight gained from empathy to focus on the problem. The design thinking of the third stage is the ideate stage, where we find many versatile solutions and ideas. The fourth step is prototyping, creating a possible prototype or model of the solution(s) to the problem. The fifth stage of design thinking is testing, where the designers test the model with real or typical users (Henriksen et al., 2019).

Art-Based Pedagogy

Basically, Art-based pedagogy is a teaching methodology where the art form is aligned with other subject areas for the insightful learning of the students, which is when a student learns about a subject through art processes, including creating, responding, or performing. Arts-based pedagogy is not about generating “fine art” to represent content; it’s about learning and thinking in another form. That form can contain poetry, pictorial arts, theater, dance, and many more. Art-based pedagogy helps learners as cognitive pluralists while conceptualizing the process of abstract mathematics or indescribable dimensions of understanding in the classroom (Barone & Eisner, 2012).

Indeed, to foster the different abilities of the learner, a pedagogical shift is necessary for the mathematics classroom. That is art-based pedagogy. This pedagogy denies a dogmatic and rigid way of mastering. It can be an opportunity to reflect on education as a whole to form a new educational paradigm that combines a more energetic, imaginative, organic, and authentic picture of how the world works, how young people learn, and how the mind understands it (Marshall, 2014).

Inquiry-Based Learning Approach

In inquiry-based learning, the emphasis is on exploring an open-ended question or problem. They must use evidence-based reasoning and creative problem-solving to arrive at a conclusion that must be defended or presented. Furthermore, inquiry-based teaching is important, as it moves students beyond general curiosity into critical intelligence and understanding. The teacher must encourage these students to ask questions and support them during the research process and understand

when to start and how to structure the research activity. Hence, the goal of inquiry-based learning is to engage students in a sound process of scientific discovery. From a pedagogical perspective, a complex scientific process is broken down into smaller, logically interconnected units that guide students and engage important structures of scientific thinking (Pedaste et al., 2015).

This process allows students to work alone or as part of a small or large group. The inquiry usually involves methods such as dialogue and guided research or practice. The teacher provides content in the form of text, audio-visual, and virtual or physical manipulative such as building blocks. Question features that introduce different content and ways of dealing with it allow for the different learning needs and desires of our students. Educational transformation away from passive transmission-based learning, recalling detached facts, and following prearranged rules and processes is not new. So, reform this tendency and produce our people as engaged thinkers, moral citizens, and entrepreneurial spirits as far as possible through an inquiry-based learning approach (Friesen & Scott, 2013).

Transformative Pedagogy

Transformative pedagogy is an advanced pedagogy that includes elements of constructivist and critical pedagogy that empower learners/educators to critically examine their own beliefs, values, and knowledge in order to develop an understanding knowledge base and acknowledge diverse perspectives (Shrestha et al., 2020). Knowledge from my research program guides me toward pedagogical change through reflective practice. Reflective practice is the second approach in my research, which helps the profession (also) to understand how I/we use knowledge in my field (pedagogical context) and how I/we engage in a critical and careful examination of professional practice to achieve a deeper understanding of the phenomenon (Brookfield, 2016). Therefore, transformative pedagogy encompasses my research to experience a deep structural change in the conventional pedagogue to empower mathematical pedagogue in fundamental conditions of thinking, state of mind, and action in participants and myself (Pant, 2017).

Empirical Reviews

I am eloquently presenting my ideas for empowering mathematics pedagogy through different pedagogical approaches. To understand the related field research, I first reviewed the article of Pant et al. (2020), which conducted a study to integrate STEAM pedagogy in teaching mathematics. They talked about the lack of teachers'

knowledge and skills in using ground-breaking pedagogical practices. This research is directed to provision and implement different projects (inquiry-based projects, stories, poems, technology-enhanced teaching) inside the mathematics classroom. This research was shown through participatory action research (PAR) in different schools in Kavre district. From this research, I found that they largely focused on the process of inspiration and selection in mathematics classrooms using the STEAM approach.

Next, I reviewed the article Das (2019) Pedagogical approaches in mathematics. In this article, he examines the most important practices of pedagogical approaches to mathematics education. In addition, he examines the responsibility of the mathematics teacher and focuses mainly on the problems and challenges of connecting mathematics and pedagogical introduction. Therefore, this article primarily focused on pedagogical approaches to teaching mathematical learning from an Indian perspective. The research methodology is a mixed method of interpretive approach where qualitative data was collected, and secondary sources such as books, articles, journals, theses, university news, expert opinions, and websites were examined.

Similarly, I reviewed the paper by Attard et al. (2018) on the importance of dialogic practices in the Mathematics Classroom. This article highlights the dialogic practices central to most pedagogical performances in mathematics classrooms. Also, the dialogue environment encourages mathematical processes such as "reasoning," "explaining," and "mathematical thinking." The content, therefore, focuses on understanding the discourse of mathematics pedagogy and its impact on students and mathematics learning through the mathematics lesson of a typical year by analyzing the transcript in two different analytical contexts. This article examined the relationship between the dialogical conditions of school mathematics teaching and the student’s experience in the classroom. There is a growing body of evidence that supports the importance of dialog-rich networks for student learning as well as classroom participation.

Research Gap

From the above review of various articles, Pant et al. (2020) discuss various pedagogical practices to support STEAM pedagogy. This study aimed to support and implements various projects, such as inquiry-based projects, stories, poems, and technology-enhanced learning, through inspiring and engaging participatory action research in the mathematics classroom. Das’s (2019) Pedagogical Approaches in

Mathematics Classroom discusses the problems and challenges connecting mathematics and pedagogical knowledge. Therefore, the paper focuses heavily on pedagogical approaches to teaching and learning mathematics from an Indian perspective. Similarly, *Dialogic Practices in the Mathematics Classroom* by Attard et al. (2018) focuses on dialogic practices central to most pedagogical practices in mathematics classrooms. The importance of dialogic communication in learning and participation of students in classrooms is also increasing.

All those articles are relevant to my research, providing a deeper understanding of my research field and context. They broadly talked about STEAM pedagogy with different projects focusing on student engagement and motivation, about pedagogical knowledge in mathematics education from an Indian perspective, and some focused on only dialogic practices in mathematics classrooms. Despite exploring the role of different issues, those articles haven't been able to connect the ideas of empowering pedagogical approaches on the line of empowering mathematics pedagogues aligning STEAM approaches in the context of Nepal. Thus, I want to explore the vision of mathematics empowering pedagogues by adapting STEAM approaches in the Nepalese context in the mathematics classroom in the Nepalese context using an autoethnographic research method. That is why it is different from others. So, this study aims to investigate the pedagogical importance of mathematics classrooms in the context of Nepal.

Theoretical Reviews

In this section, I discussed the relevant theories required as my research questions and the quest throughout the research. I have incorporated the theories to solidify my research agenda in my autoethnographic inquiry. Hence, the selection and the structure of the theories assisted me in the process of meaning-making.

Transformative Learning Theory

We have to develop a critical worldview in the search for a better understanding of our world (Taylor, 2017). Transformative learning tries to hold in the different dimensions of human activities, such as collaboration, interdisciplinary connection, communication, critical reflective thinking, etc. As Stetsenko (2017) has noted, knowledge varies in a particular context; location and the situation may not always be perfect. Humans learn through the interrelated process of being, knowing, and doing, which assists in collaborating transformative practices. In fact, transformation is a shift in consciousness to a higher level of awareness and

understanding of self and others and the complex interrelationships of all (Taylor et al., 2012).

Hence, as per my research agenda to reach the pedagogical transformation, transformative learning theory helped me to be a critical reflective researcher assisting higher levels of consciousness and understanding of self and others. As my research question, shifting (not shifting) views of pedagogies to empower learners through a holistic meaning-making process from the conventional phase, transformative learning theory helped me to generate my ideas metaphorically. My participants and I acted *as involved gardeners* (involved + active + artistic). Therefore, the meaning-making process of my research is unique and changing (Mezirow, 1991) because the research itself is a learning process in which new and revised understandings of the meaning of stories are constructed and acquired**.**

Knowledge Constitutive Interests

Habermasian knowledge constitutive interests (1972) is another theoretical model that provides synergy between my prior experiences (stories, events) and me to legitimate transformative pedagogy through different technical, practical, and emancipatory situations. In my inquiry, I applied three forms of constitutive, technical, practical, and emancipatory interest, to identify the different stages of the knowledge generation process. I used three stages to test the transformation or shift of the pedagogical practices to conventional pedagogical practices to empower the STEAM approach in the mathematics classroom.

The technical interest helped my participants and me to examine our beliefs and granted assumptions towards the technical and pedagogical practices. The technical interest in mathematics pedagogical practices is memorizing the facts for examination. This fundamental interest helped me to examine the rigid pedagogical structures and students' perceptions through narratives. Similarly, practical interest helped me to gain a situated understanding of the environment through dialog and collaboration (Pant, 2019). My research aims to empower the learner through transformative pedagogy in the mathematics classroom. To achieve the goal, I also critically evaluated my deep-rooted beliefs. Teaching is for the emancipation of students by addressing their common understandings and practices, enabling the learner and the educator to transform the learning environment (Pant, 2019).

Transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), and critical pedagogy (Freire, 1993) gave me a theoretical

road map for my research inquiry. Those theories helped me to solidify my ideas through the field text and my participants' and my (as required) lived experiences. Similarly, this theory helped me to shift from conventional to empowering pedagogues. So, this theory helped me to evaluate my deep-rooted beliefs critically and to adapt to the change. Hence, those are the boundary conditions to construct meaning and legitimate the meaning.

CHAPTER III
RESEARCH METHODOLOGIES

I have argued my study's research methods and approaches in this chapter. Furthermore, I have described the methodological details developed for this research. Firstly, it presents the philosophical considerations and research paradigm, followed by the research method. Then, it includes information about research sites and data collection techniques. This chapter also deals with the data investigation process. The chapter's final part presents the study's quality standards to validate my research and the ethical considerations I considered in my research work.

Philosophical Assumptions

Autoethnography is the best avenue to envision my *pedagogical shift through the STEAM approach* in the mathematics classroom. Hence, to accomplish this task, I have used autobiographies, stories, reflections, art, and drama, etc., as stories with numerous logics and genres; photography as an art-based appearance; and ethnography as a methodological context within multiparadigmatic design space (Qutoshi, 2015). I have described philosophical considerations in this section to comprehend better what constitutes knowledge. Under philosophical considerations, ontology, epistemology, and axiology are considered.

Ontology

Ontology refers to the nature of reality (Neuman, 2016). For me, the reality is that there are different ways of inquiry to make a vision about empowering mathematics using different pedagogical approaches. Researchers may use different ways of inquiry with different perspectives. It relates to how people perceive the social world (Guba & Lincoln, 1994). They may have their understanding, experience, and perception toward pedagogical shifts or practices. So, my ontological assumption is that I own multiple realities throughout my educational journey associated with my research participants who contributed to my teaching and learning.

Moreover, my ontological posture is relativism, as there is no fixed single, absolute, and universal truth. Reality or truth changes with time, situation, person to person, context to context, and so on. Every individual may construct the subjective meanings of their own experiences and understandings. So, reality is completely

context-based and socially constructed. In other words, I believe in the multiplicity of opinions, experiences, and contexts.

Epistemology

The epistemological issue is that human knowledge is contextual, constructed, and transformed from the previous generations. Moreover, it concerns knowledge and how it can be constructed. In my research, epistemological assumptions help me to envision the knowledge construction process through different pedagogical approaches in the mathematics classroom.

Furthermore, knowledge is constructed through intersubjectivity, i.e., through interaction with the self and others, i.e., acquiring the experiences, feelings, perceptions, and meanings within relative contexts. To achieve this, as Creswell (2008) asserts, I tried to maintain closeness and collaborate with my participants, spending nearly seven weeks until completing my research target (as necessary). Now, realities are constructed by social actors through social interaction. Thus, I accepted that knowledge is co-constructed by me and my research participants and generated from the research process.

Axiology

An axiological issue in my research is the value of trust and openness in research relationships. The researcher's epistemological stance is understanding how knowledge is created, acquired, and communicated. Cooper et al. (2016) axiology is the study of the nature of the value of knowledge. My research depended upon my stories/vignettes/drama/images, etc., associated with my participants, research site, research context, and researcher's and participant's perspectives sharing different ideas with their beliefs and values may take place this study, so it moved accordingly. Similarly, I highly valued/respected the alternate and/or opposing perspectives of my research participants throughout the research process before, during, and in the survey or gathering of field text.

Paradigmatic Research Design

My research study aims to dig out my own and the participants' un/successes journey in the academic field regarding teaching and learning panoramas. A paradigm is thus a widespread belief system, worldview, or outline that controls research and practice in a field (Taylor & Medina, 2011). To support this notion, I tried to be an empowered pedagogue on mathematics education using different paradigms of criticism, interpretivism, and postmodernism.

Interpretivism

The interpretivism helped me to view and understand other cultures from the inside by learning to ‘stand in their shoes,’ ‘look through their eyes,’ and ‘feel their pleasure or pain’ (Taylor & Taylor, 2019). I tried to recognize the culture or tradition of using different ways of using inquiry-based instruction through interaction with the teachers. In this research, realities are, as Neuman (2016) asserts, what people perceive to be different from participant to participant regarding the ways of using different pedagogical practices and visions. I used it to generate meaning and actions of my aspects while using methods or approaches in teaching and that futuristic vision for pedagogical changes. Knowledge itself is relativist and is not static (Richards, 2003). Being a researcher, I took a subjective stance that seeks knowledge as something formed through the interaction between the world and the individual. Hence, the interpretive paradigm in my autoethnographic inquiry helped to create a context-based understanding of my opinions, beliefs, and values and connected with social activities (Qutoshi, 2015).

Therefore, the main goal is to understand other cultures from the inside through an intersubjective process of knowledge creation. The interpretive paradigm is a humanistic paradigm of educational research that identifies another culture through a long interaction process. Thus, it helped me to create a local understanding of life-world experiences, which means that with this paradigm, it is possible to reach the basic reality of the event.

Criticalism

In my research, the critical paradigm allowed me to change my critical self-awareness, understanding, and the formation of meaning in my world, which has been formed for a long period in the related profession (Luitel, 2009). Furthermore, the critical paradigm supported me in assessing and involving a critical meaning-making process to maintain an interactive rapport between the researcher and the participants and to examine the impact of social and historical factors that influence us (Dammak, 2015).

On the other hand, critical thought is very important in my research because it helped in many critical aspects. For example, in different classroom cultures/settings, the hierarchy of thought with many hidden obstacles is encouraged by questioning dominant systems of culture and the opening up dialogue concerned with critical awareness. This awareness offers a different kind of inquiry-based learning with the

collaborative model by constructing a tangible prototype of ideas and concepts reflecting through design thinking (Culén & Gasparini, 2019). Hence, the critical framework (paradigm) helped me to develop transformative, imaginative, and creative leadership to envisage suitable pedagogical (STEAM) approaches to become an empowering mathematics pedagogue.

Postmodernism

I used this paradigm to perceive the world differently. Every event cannot be expressed well in everyday life, but it is very important (intuition, relational and spiritual). As an autobiographer, I have tried to capture these senses beyond our calculation that the main source is Art (A). So, I employed the postmodern paradigm using various logic and genres (Luitel, 2012). Instead of relying on one approach to knowing, postmodernists support a pluralistic epistemology that develops multiple ways of knowing. Postmodernists reject the idea of a fixed, universal, and endless foundation for reality. They argue that because the truth is in part culturally dependent and culture changes over time and differs from community to community, we can logically assume that truth is not the same for everybody. Knowledge is primarily fragmented and unstable. Postmodernism is applied mainly in the artistic and social sciences. Postmodernism accepts the basic ontological assumption of relativism.

A multiparadigmatic design space is a suitable design space for transformative research design. As Luitel (2012), merging different design spaces promotes holism in new social sciences in qualitative research design. So, a central aspect of the *critical* research theory for transformative intending is to encourage social fairness, with practitioners acting on the world to make it more democratic, fairer, unbiased, and larger. *The constructivist* theory will help to make an interconnection (harmonious relation) between the participants and me. P*ostmodern* theory will help me to evoke critical consciousness and reflexivity, question assumptions, and develop the logic of empowerment. For that, I will employ various logic and genres. “A paradigm is thus a wide-ranging belief system, world view, or framework that guides research and practice in a field” (Taylor & Medina, 2011).

Hence, as an autoethnography, I have tried to capture the inherent ideas of intuition, relational, and spiritual parts of me and my participants in the meaning-making process. The different forms of images and the imageries helped me in the inquiry process to express my views and practices in pedagogical transformation using the STEAM approach.

Autoethnography as a Research Methodology

Autoethnography is a variation of thinking outside the box, critically considering different ways of perception and offering help to realize new relationships between authors, audiences, and texts (Qutoshi, 2015). Additionally, autoethnography rolls out an insider knowledge of cultural experience, which gives the context of life grown in the barrier of culture (Jones & Harris, 2018). Insiders provide more truthful and accurate knowledge than outsiders. Thus, it helped me to develop a cultural understanding and transformation of self and others. From this understanding, researchers try to see things from the viewpoint of group members, which requires extended exposure to the field. “The researcher is often a participant observer in researching and context interacting with a group.” As a researcher, I used autoethnography research design to explore the ways, actions, beliefs, experiences, etc. of research participants.

The multiparadigmatic (criticalism, interpretivism, postmodernism) notion of autoethnography research envisions empowering mathematics learning through different pedagogies applied in the mathematics classroom for pedagogical transformation. Hence, autoethnography methodology stands for a critical project for understanding society and culture at a deeper level, interpretivism assisted in knowing the social reality as what people perceive differently, and postmodern helped me with an artistic way of representing my past and present activities that will depict a clear picture of the interpretation and analysis of the context.

While adopting the method of autoethnographic inquiry, the researcher tries to knit his own experiences systematically. He shall be a participant in that research as well. This method is the relational practice of culture, shared values and beliefs, and shared experiences that help insiders (cultural members) and outsiders (cultural visitors) to understand the culture better (Ellis et al., 2011). Autoethnography is, therefore, a deep understanding of people and their culture shared by the researcher and the participants. Ultimately, this helps the researcher to identify the true state of the context.

Research Site and Research Participants

As an autoethnographic researcher, to the demand of my research, I am one of the participants of this study. So, I critically evaluated my experiences, feelings, and thoughts as a mathematics teacher in the line of pedagogical practices throughout my teaching and learning journey with the objective of the pedagogical shift from conventional to progressive. It helped me inquire into my and others' lives, which were documented in textual form through narratives, stories, and previous images and imageries. Hence, the major objective of my autoethnography inquiry is to discover anecdotal and personal experiences of self and attach this autobiographical story to wider cultural and social meanings and understandings to enhance the meaning-making process.

Meaning Making Process

Autoethnography is a system of qualitative research in which the self-researcher uncovers anecdotal and personal experiences through self-reflection and writing and relates that autobiographical narrative to understanding broader cultural, political, and social expressions and phenomena. Similarly, I have constructed textual information or my experiences for a wider group of mathematics teachers. In the process of meaning, I examined myself critically, identifying supporting assumptions and recreating them through scientific understanding and imagination (Luitel, 2009).

In addition, I planned and applied multiple logics and genres in writing stories to help clarify and analyze informational text. There are several new logics, but I explored metaphorical, narrative, dialectical, and figurative texts to explore my experiences as a teacher and educator (Luitel 2018).

Quality Standards

I have tried to maintain quality standards to make my research significant. I have conducted my research study with morality and ethics at every research step. During the investigation, I tried to be moral about narratives, experiences, and discoveries. I have used the quality standards of the research positioning with multiple research paradigms in my research. So, I have followed interpretivism (trustworthiness), criticalism (critical reflexivity), and postmodernism (pedagogical thoughtfulness and verisimilitude) to match quality standards.

Trustworthiness

The interpretive paradigm encompasses participants' stories to make deep meaning to know them about the framework. The trustworthiness ensures the

scholar's deep understanding of the meaning and perspectives of the participants. Maintaining trustworthiness includes credibility, transferability, dependability, and conformability (Guba & Lincoln, 1989). I have planned to do a prolonged study of participants (me) in their social world.

Trustworthiness is maintained by an observable thick description expressing the participants' voice, confirmed through member checking. Also, it is tested by seeking evidence to disconfirm implications arising from grounded theorizing. According to Taylor (2014), visibility and unfolding subjective voice with probabilistic reasoning optimize trustworthiness in my research.

Critical Reflexivity

As a notion of critical paradigm, I have tried to maintain quality standards of critical reflexivity or critical self-reflection method of understanding perceptible to readers. Then, I consciously reflected upon my assumptions, beliefs, and progressing subjectivities throughout the research inquiry process (Luitel, 2009). It further helped me to be attentive to the limitations of my chosen epistemological stance/s of personal and methodological concerns. Hence, as Shrestha (2018), I have tried to maintain the quality standard of my research through critical reflexivity, making the process of interpretation visible to readers by critically reflecting on my assumptions and consciously and critically reflecting upon my false consciousness throughout the research inquiry process.

Verisimilitude

The post-modern paradigm allowed me to use multiple logic and genres to maintain the verisimilitude of my research study. By following the quality standard of verisimilitude under post-modernism, I have subscribed to narratives, vignettes, and stories by using different genres to make my research texts realistic, plausible, or believable to the readers (Luitel, 2009). Similarly, as I have crafted the stories of my participants and me, verisimilitude criteria have made my research participants' stories more realistic and believable. They have engaged in a flow along their teaching and learning journey by making them emotional and empathetic. The autoethnographic research stories helped to maintain the truthfulness and lifelikeness in the pedagogical transformation of my participants and myself.

Pedagogical Thoughtfulness

This quality standard captures the researcher and participants, allowing them to reflect on their values and beliefs critically in their ongoing narrating. Critical

reflection, in the sense of teaching and learning, gives rise to pedagogical thoughtfulness. My research helped me identify the pedagogical practices inside the secondary-level mathematics classroom and above. Pedagogical thoughtfulness helped to make the researcher and participants stronger, more flexible, and open to new knowledge. The attention to these standards helped me produce quality research tasks evoking pedagogical thoughtfulness with an emotional part to the stories of lived experiences (Qutoshi, 2015).

Hence, for the transformative research, I tried to consider the values, ethics, and integrity part of the research from rapport building condition at the end of the research task. Ethical consideration is very important to achieve the ground-breaking reality from the participants. Otherwise, we could not get the real data, so transformation would be lost.

Ethical Standards

Ethics refers to the code of professional conduct or norms determining what is acceptable and not the intellectual work. Research encompasses activities from selecting the research topic to the final analysis, interpretation, and presentation stage. As an autoethnographer, I have tried to protect the pride of my research participants by preserving the academic norms and values of the research participants, institutions, and community. Also, they are highly respected and acknowledged, and their identities are disclosed. This consent form was obtained at each interview and observation to ensure the participants still wanted to be part of the research elements (Ellis, 2007). Also, the main ethical considerations are informed consent, privacy, confidentiality, and anonymity of research (Cohen et al., 2011). Hence, I tried to maintain the above criteria through narratives, interviews, and exchanging ideas.

CHAPTER IV
MY EXPERIENCE AS A CONVENTIONAL PEDAGOGUE

Therefore, this chapter addresses my first question as a mathematics teacher: How did I teach mathematics as a conventional pedagogue? I have spent many years teaching in different schools and colleges, intending to make my students secure better grades, thereby improving the school's records. To fulfill my objectives and the school's administration, I needed to develop my skills to handle students inside the classroom. My identity was established as a teacher with the notion of an army commander as a target receiver. I had spent eight years promoting the same situations in teaching and learning activities in the same institution. In the previous chapter, I articulated how and why I was compelled to adopt conventional teaching methods/pedagogies. In this chapter, I am trying to portray what disempowering features of the conventional way of teaching mathematics provoked me to adhere to conventional teaching and learning mathematics in the classroom. Also, I will critically reflect upon my pedagogical practices and explore my pedagogical status and students' learning status between cognitive and affective domains.

Moreover, I have attached the condition of banking pedagogy, which was/is promoting a conventional approach to teaching and learning mathematics. That helped me to identify the increasing gap between teacher and students, students and mathematics, and society and mathematics because of the extensive focus on the cognitive domain and less focus on the affective domain of teacher and students.

As per the structure of my proposal, chapter IV represented my first research question, "How did I teach mathematics as a conventional pedagogue?" and explored how I came to realize the meaningful aspects of a conventional pedagogue as a mathematics teacher and assimilate both conventional pedagogue and empowering mathematics pedagogue through STEAM approach.

Here, I have presented five narratives: Teacher as a drill-and-practice promoter; Practice makes a student perfect; Is this final exam question, sir! I need a good result in SLC (SEE)-Principal; Chant the important theorem ditto no alternative idea: pass the final exam.

Teacher as a Drill-and-practice Promoter

"Until and unless you do not practice mathematics several times, you can never solve mathematics problems." This is my rhetoric, which I usually use in my mathematics classes. That's why I have used the metaphor '*Teacher as a drill-and-practice promoter*' to refer to myself as someone who taught only to obtain high marks in the examination. The suggestion from the principal for only securing good marks in every examination was the strategy for the existence of the private school as well.

It was the day of September 2004 when I was appointed as a secondary-level mathematics teacher in one of the private schools of Butwal. That was my first class in grade ten. While selecting me, I had given class observation in grade ten. After that, he called me into his office and said, Well done! The ball is in your court! Then, I washed my brain in teaching and learning activities as he follows in his school. At that time, he suggested that mathematics teaching referred to only solving problems and reading inside the class. Also, he believed that the teacher who could control his/her students in the class and teach in a pin-drop-silence environment was/is considered a successful and excellent teacher. He added another point that the previous math teacher could not control the students, and they achieved low grades in mathematics in S.L.C., so he made him compel to leave the school.

- Work Done = Time Taken × Rate of Work
- Rate of Work = 1 / Time Taken
- Time Taken = 1 / Rate of Work
- If a piece of work is done in x number of days, then the work done in one day = 1/x
- Total Wok Done = Number of Days × Efficiency

After taking black tea with him, I returned home and thought that I had to do as per the principal's techniques to control the students with a pin-drop silence environment and make them (students) secure good marks in the final examination. I entered grade ten the next day and started the lesson *time and work.* On the first day, I gave some ideas, keynotes, and shortcut methods to solve the problems related to time and work.

First, I told them that they could learn the formula by looking at the examples in the book and could apply the formula to find the answer. At that time, students were not supposed to ask questions. I thought the same as Ayers (2012): The teacher

was a *transmitter of knowledge, and students were receivers.* They could not ask for the formulas to be deriving or any practical application of these activities. They could not guess any application in our daily activities. Similarly, Gutstein (Pant, 2019) states that mathematics for all was not applicable in my classes. I believed mathematics was only for me as a content transmitter (applying one-way knowledge transfer). I only gave the formulas and the solution to every question, and the formulas had no logic or reasons.

Carrying this way of teaching inside the classroom, I also followed the same agenda opposing Pant (2017), "The notion of the algorithmic genre was dominant in the school level mathematics." The algorithmic way of mathematics teaching was/is a highly complicated process for students. After completing the book examples, I randomly selected one question from the exercise and solved it as I gave them formulas. Then, most of the questions were from the question bank. For instance, The time taken by A to finish a piece of work is twice the time taken by B and thrice the time taken by C. If all three of them work together, it takes them 2 days to complete the entire work. How much work was done by B alone?

Solution: Let Time taken by A = x days

As per the question,

Time taken by B = x/2 days

Time Taken by C = x/3 days

⇒ {(1/x) + (2/x) + (3/x) = 1/2

⇒ 6/x = 1/2

⇒ x = 1/2

Time taken by B = x/2 = 12/2 = 6 days

My Explanation, you know I have repeated these formulas as I had written. In such question you have to strictly follow the same rule ok. *
Rate of Work = 1 / Time Taken
* Time Taken = 1 / Rate of Work
* If a piece of work is done in x number of days, then the work done in one day = 1/x

In the same manner, I continued my teaching, which made it easy to solve such problems for the students, but if I twisted questions somehow, they could not attempt them. As far as possible, I used to ask them questions about my question-solving tricks and methods; they used to tell me, "*Sir, we simply enjoy doing mathematics till we get correct answers, but it makes us tense when we cannot get correct answers.*" I replied, "*Yes, it's true, but always follow the table to find the correct answers as easily as I have given, provided that you must have already*

memorized all the formulae." The first girl in the class immediately replied to my comment, "*Yes, Sir! It's true. I always follow your footsteps and methods to find the correct answer. I feel easy solving problems when I can find patterns, as you always suggest in the classroom.*" Nowadays, it reminds me, as Egan (1997) stated, that *the facts and algorithms we teach our students will no longer be viewed as meaningless symbols and abstract ideas but as the product of human passions, hopes, and fears. The* students could not connect each mathematics work to their daily activities due to the algorithmic learning in their study.

Let me portray the next incident that happened in my classroom. It could be any day in 2003 when I entered grade ten as a class teacher, all the students stood and put greetings. I told them to sit down and started my task without looking at their faces. "Dear students, today you will practice problems from 55 sets practice book… For this, I will solve this problem, and the remaining questions are for you, ok!" That task/topic was constructing and solving linear equations as given in the question. The question was, ***"Altab tells his daughter, "Seven years ago, I was seven times as old as you were. Also, I shall be three times as old as you three years from now." Construct linear equations and solve them.***

Solutions: Let the present age of Aftab be 'x'.
And the present age of his daughter is 'y'.
Now, we can write seven years ago,
Age of Aftab = x-7
Age of his daughter = y-7
According to the question,
$x-7 = 7(y-7)$
$\Rightarrow x-7 = 7y-49$
$\Rightarrow x-7y = -42$ ……(i)
Also, three years from now or after three years,
The age of Aftab will become = x+3.
The age of his daughter will become = y+3
According to the situation given,
$x+3 = 3(y+3)$
$\Rightarrow x+3 = 3y+9$
$\Rightarrow x-3y = 6$ ……(ii)

Remember That: First of all, let the variables as required in the question. Then, perform the question as
Before (-) Ago (-)
After (+)

Subtracting equation (i) from equation (ii) we have

$(x-3y) -(x-7y) = 6-(-42)$

$\Rightarrow -3y+7y = 6+42$

$\Rightarrow 4y = 48$

$\Rightarrow y = 12$ and $x = 42$ This seems that Altab's age is 42 years, and his daughter is 12 years.

Then, I asked them if they understood. In the meantime, the first student in the class, Suprya, said yes, sir! I have completed all the exercises just as your tricky method of solving. But other some were taking help of (others) talent one. I have suggested that all follow my tricky method as given in the table, and all the questions will be solved. However, all of them were not happy in their face.

While solving these questions essentially, I used trick and technique methods in the classroom because (as a mathematics teacher) I had a deep-seated belief that mathematics is more manageable than other subjects. It is because this subject does not require creativity like others. A few *bundles of formulas* must be memorized and used frequently in various algorithmic problems. That is all. So, I always had recommendations for my students to memorize the formula, like a procedure, a series of steps or actions to finish a particular objective (Rittle-Johnson & Schneider, 2014). Also, that knowledge of procedures is often termed procedural knowledge, and they go through rigorous practice of several algorithmic mathematical problems if they want to be brilliant in mathematics.

Most mathematics classrooms focus on procedural knowledge because our mathematical solutions are related to the cognitive process. Procedural and algorithmic processes are also vulnerable in science and mathematics learning. However, this dimension is necessary but not sufficient in learning mathematics. On the other hand Luitel & Taylor (2005) urged that contextualization of mathematics is a process of adopting the concept of mathematics concerning the social and cultural values of the place where the learners live. In this regard, I realized that only drill and practice methods of teaching and learning could not be sufficient for meaningful mathematics learning for students; instead, mathematics should be linked to students' social and cultural values. Thus, my issue was not to completely deny the drill and practice method. Instead, my concern was to reduce the hegemonic presence of drill

and practice/rote memorization to pursue possible ways of meaningful mathematics learning in the classroom.

Pedagogy as Practice Makes the Student Perfect

Many people, including me, consider Mathematics a solid and rigorous subject. According to the previous and present mathematical concepts, it cannot be learned without practice. This concept explains that learning mathematics is directly proportional to the practices performed by the learner. Standing on this position, mathematics learning culture is based on practice, practice, and practice. During my teaching experiences, I always promoted such strategies rigorously in classroom teaching. Implementing these strategies, I have faced various responses from students, colleagues, and school administration. When students made some minor mistakes, my colleagues and administration commented on my practicing performance. Similarly, if I found such mistakes from students, I used to advise them to participate more and more in practice.

One morning in January 2005, at around 7 a.m., I entered class X. I suggested to students, “Dear students, today we will practice problems from last year’s final exam question of School Leaving Certificate (SLC). So, discuss each other and solve the problems. Remember that it’s only about three months to appear for the exam for the School Leaving Certificate”. This is how I instructed you to solve problems from the old bank! Today, we are engaging in geometric theorems; theorems are like universal truth, so practice carefully. For that, you all should know the following relations: theorems. You know all, more practice makes you perfect in mathematics. So, read and read those statements of the theorem; then you will be able to solve the circle and tangent-related problems, ok!

1. The central angle subtended by two points on a circle is always twice the inscribed angle subtended by those points.
2. Angles formed in the same segment (either major segment or minor segment) of a circle are equal.
3. An angle in a semicircle is always a right angle (measures 90 degrees).
4. The perpendicular drawn from the circle's center to a chord bisects the chord.
5. Two equal chords of a circle subtend equal angles at the circle's center.

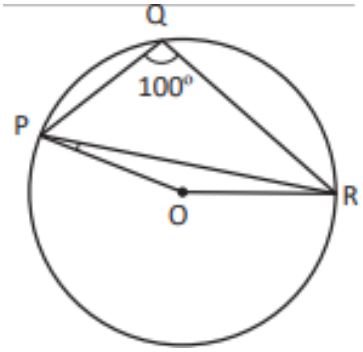
When you remember these above theorems, you will know how to solve the different questions related to the circle and tangent as,

In the given figure, ∠PQR = 100° and the points P, Q and R are the circumference points of the circle with the center O. Find the value of ∠OPR.

Solution: according to the figure,

(i) Reflex angle POR = 2 × ∠PQR = 2 ×100° = 200° [The central angle and the inscribed angle based on the same arc PR]

Figure 2
Geometrical Drawing (Sources Google)



Reflex angle POR + obtuse angle POR = 360° [Sum of the angles around the point O]

Or, 200° + obtuse ∠POR = 360°

Or, ∠POR = 360° – 200° = 160°

iii) Again, ΔPOR is an isosceles triangle.

So that, ∠OPR = ∠ORP ⇒ ∠OPR + ∠ORP + ∠POR = 180° [The sum of the angles of a triangle]

or, ∠OPR + ∠OPR + 160° = 180° [∠OPR = ∠OPR]

or, 2∠OPR = 180° – 160° = 20°

or, ∠OPR = $\frac{20^{\circ}}{2} = 10^{\circ}$

while doing this theorem, I wrote a related question on the blackboard: "*In the given figure, ∠PQR = 100° and the points P, Q, and R are the circumference points of the circle with the center O. Find the value of ∠OPR*", I began to solve it by explaining stepwise.

My explanation: Based on the theorem statement, you must draw and label a correct figure. (I draw a figure accordingly) and

My Explanation: After drawing the figure, write the given things based on the labeled figure and then establish the conditions as I had told you to remember those theorem statements.

This is how I would teach geometrical theorems so my students could grow into the matter and show their interest in geometry. (Ubi et al., 2018) Recommends that "The reason is given for viewing geometry concept as difficult is. As a result, irregular class practices, unavailability of instructional materials, teacher's method of teaching, bad and inadequate timing, etc." "It states that the geometry learning process is too tedious and lengthy for the learner for various reasons. So, most of the students refuse to practice/know geometry.

Despite the above matters, we all know that geometry is vital in developing students' logical reasoning abilities. However, what I mostly found during examinations always teased me as most students rarely solved geometric problems. They lacked geometrical reasoning and proof. I was so proud of myself for explaining things stepwise to my students, realizing everyone understood how to prove theorems. Nonetheless, I feel now that I was totally in false consciousness and realize that I was revealing the being part of geometric theorems using a reductionist pedagogical approach as such asserts that "Reductionism takes many forms but generally signifies a loss of complexity which hinders an adequate understanding of reality" Jones (2000).

I come to realize now that I was not able to catch the becoming part of geometric theorem or, more precisely, that I was unable to see what my students would learn practically after providing them with such procedural skills of solving geometry theorems. However, my effort to reinforce learning geometric theorems by using a reductionist pedagogical approach gradually persuaded my students to follow a linear learning path, resulting in their improvement in scoring better marks in Geometry (I. M. Shrestha, personal communication, November 27, 2016; Shrestha et al., 2020).

I realized that I was transmitting routine skills and instrumental knowledge to my students via reductionist pedagogy for practice that makes a student perfect. Sometimes, I would wonder why I was teaching geometry theorems, which my teachers had already proved. Why? However, I did not tend to think critically and never allowed students to think critically. So, to promote meaningful, authentic, and inclusive education, "*the pedagogy practice makes students perfect"* is partially sufficient, so we have to adopt progressive pedagogy to foster transformative learning while placing imagination, intuition, and emotion at the heart of transformation (Kroth & Cranton, 2014; Shrestha et al., 2020). Then, we can feel/realize the meaningful, authentic, and inclusive education. Furthermore, "If creativity, collaboration, communication, and critical thinking all rooted as hallmark skills for 21st-century success are to be cultivated, we need to ensure that STEAM subjects are drawn closer to the arts" (Piro, 2010). Hence, the practice makes students perfect pedagogy is insufficient in mathematics classrooms to achieve the hallmarks of 21st-century skills and to cope with the different situations of the nations/world problems.

Sure, Questions for the Final Exam!

It could be June 2011; it was a sunny day, and the ceiling fan was running in its motion. Students were waiting for me for the mathematics class in the first period when I entered the classroom with a low-pitched voice. Hello, dear student, good morning! Today we will practice crucial exam questions, ok? You know all, "*Mathematics is nothing but just a bundle of formulas. So memorize them thoroughly and use them appropriately. That's it!*" yes, you got the point! Most students said, yes, sir, we need marks, sir, no need to be extraordinary students.

Then, I started to write on the board SLC/SEE possible questions from the question bank. From the chapter-11 and chapter-13 are Construction and Statistics. Also, I added that today, we will try to remember those questions and processes. I will ask you some questions, OK?

Q 1. Construct a triangle ABC in which AB = 4cm, BC = 6.5cm, and ∠ABC = 120°. How can we construct a parallelogram with a side PB = 5cm and equal to the area of DABC?

Q 2. Construct a parallelogram ABCD with AB = 4cm, BC = 5.5cm ∠ABC = 60°. How can we construct a parallelogram whose area is equal to the area of parallelogram ABCD? When, Parallelogram ABQP having an angle 120^0.

Q 3. Find the mode from the data:

Weight (Kg)	30-40	40-50	50-60	60-70	70-80	80-90	90-100
No. of Students	3	5	7	11	10	3	1

Q 4. Find the first quartile (Q_1) and third quartile (Q_3) from the following data.

Age (Year)	20	25	28	30	32	35	42	46
No. of Workers	2	8	12	10	14	7	5	1

Firstly, I solved the problems with its procedures with a compass, pencil, and eraser kept on the side. Only I spelled out the process, and students followed my steps rather than asking questions because those questions were the probable questions of the final exam. Ok, the question is the first number as I have written on board,

Solution of question no. 1 process

i. Draw a rough sketch of parallelogram ABCD according to the given data.

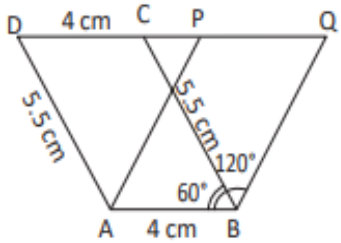
ii. Draw AB = 4cm

iii. Draw an angle of 60° at the point B. Again, take an arc of radius 5.5cm from point B, cut the line from 60° at B, and name point C.

iv. Now, let us give the name to point D, where a 5.5cm arc from A and 4cm from C are intersected.

v. Now, parallelogram ABCD is prepared after joining D with C and A with D.

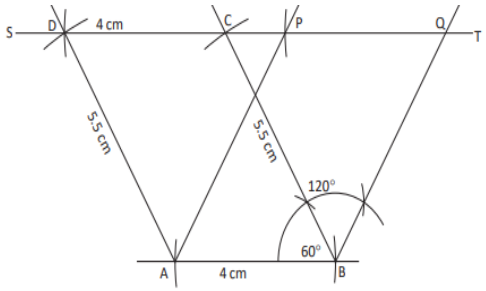
Figure 3
Geometrical Drawing (Sources Google)



vi. Extend DC up to T. Construct an angle of 120° at point B and name the point Q where the line ST meets.

vii. Take an arc equal to AB, cut QS from Q, and name the point P. Join A with P. This is the final product of constructing a parallelogram with an angle of 120° with equal area. Hence proved.

Figure 4
Geometrical Drawing (Sources Google)



After that, I left the class and suggested they do all the questions I gave you on the board. The next day, I came and started with those important questions and asked the final answers. Only four or five students submitted their homework.

In the meantime, I found a group of boys on the second last bench, reading something in a homework copy and laughing. When asked, one of the boys showed me the copy, in which I found a quotation of a confession written to Math by a boy who hated mathematics and hence had no interest in learning mathematics. I have presented his confessional word as it is upon his agreement: "*Dear Math, please grow up now and solve your problems yourself".*

When I read this in his copy, I scolded him badly. Do you not have any tasks? Have you practiced as I was given yesterday? I asked some questions from the old bank and wondered why he had written such words in his mathematics homework copy. It made me think and rethink it. When the students started their tasks as classwork, many circumstances were moving in my mind regarding that event.

Instantly, I planned to ask him about his quotation and why/how he had written that and went to near his bench and pursued him to be close to me and ask questions.

I kept smiling at him and asked him for consent to use it in my research inquiry. And why does he hate Mathematics? I just asked him informally many times. He repeatedly said, “I hate Mathematics because when I practice at home early in the morning, I forget it at school.” You say, sir, practice makes a man perfect! “Practice, practice, and practice”; disappointed me, sir! Sorry, sir, I told you from my core heart. Do not mind. I said, “That’s fine, no problem.” He continued, “You know, Sir. After SEE, I will squeeze, tear, and throw all Mathematics and exercise books into the wastebasket.”

Now, a question arises in my mind: Where is the problem? Seeking the mathematics curriculum's problem-heavy contents always burdens teachers, which transfers the load of engaging students the whole day in school, thereby losing their creativity and a low impression towards mathematics and math-related subjects. I agree that teachers who plan and carry out practice instruction must identify in the curriculum (Franke et al., 2007). Students with low levels of math skills can also successfully perform higher-level skills through adequate mathematical practice on component skills. Instead of attempting to cover every skill and its application, teachers can teach a core set of skills and strategies for synthesizing them that will produce novel combinations and applications without further drilling (Mayfield & Chase, 2002).

According to Habermas (1972), technical interest learning occurs according to that theory's theory and technical practice. Based on this notation, my teaching strategies completely followed the mathematical teaching concepts in classroom performance, and I prioritized practice and practice methods in the classroom.

From the above discussion, students were found to believe in practice methods for better performance in mathematics learning. When I was engaging the students in more and more mathematics practice in the classroom, I found that the school administration was happy with my job, and I was considered a model of a good teacher in my school. Therefore, I practiced this method in classroom activities every year without considering innovative teaching methods. Therefore, learning becomes meaningless when the knowledge and skills are taken separately. Achieve the meaningful learning of mathematics, connectedness between knowledge and skills must be seen.

I learned that we/ are transforming the burden of mathematics through our teaching pedagogy. As mentioned above, my student says, "*After SEE, I will squeeze, tear, and throw all Mathematics and exercise books into the waste basket."* Furthermore, our learning geometry methods are too conventional because we compel our students to rote recall in the final exam. So, that narrative made me think! Parroting pedagogy is largely painful and problematic to the learner. As a result, most of the learners try to avoid mathematics and related subjects from their educational periphery. So, educational transformation is possible when the students are ruled by skillful knowledge **(**Gardner, 2008).

Furthermore, authentic, meaningful, and inclusive learning helps educational transformation. Here, authentic learning is a learning approach where students discuss, explore, construct concepts, and make relations about the given problem. So, largely authentic learning is guided by constructivist theory. Also, authentic learning is an interdisciplinary primarily approach. Similarly, to attempt meaningful learning, we must address the many aspects, firstly contextualize (localize the knowledge through culture, environment, etc.) the subject per the nation's demand, transformative learning approach, inquiry-based learning model, etc. To address inclusive education or to attempt the goal of the slogan "*education for all*" many obstacles must be eliminated through different learning approaches and policies regarding those learners.

I Need Good Results in SLC!

"*Dear teacher! As we all know, we cannot survive if our students cannot achieve better results than our neighboring schools!"* This type of singing is usually sung by the school's principal, where I taught for 6 years, from 2003 to 2009 AD. It could be the day of September 2007; almost all the secondary level teachers were busy completing the grade ten courses because the final exam/SLC date was too near. I was also in class X, section Alpha. The principal was out of Butwal for a few days. Suddenly, a peon knocked on my classroom door and told me to join the meeting. I went to the meeting hall and sat at the round table for the meeting agenda. The principal started meeting with how to improve the SLC/SEE result, targeting the first position in the district. And added Vice Principal Panday: You have total authority over how/what to teach students in a classroom, semi-hostel, or full hostel? We have to know they are paying for a better result.

Principal: Dear teachers and coordinators! As we all know, we cannot survive if our students cannot achieve better results than our neighboring schools, so you have to pay full-time math and science teachers rather than other teachers.
Me: Yes, sir! I come to school at 5:30 AM and leave at 8:30 PM for the last three months.
Principal: yes! That's fine. All the students must pass the exam, and Alina (the first girl in class X) must be topped in the district. You make them Practice and practice to get good results in the final exam. We all took black tea, and the meeting ended. We went again to the class.

According to this meeting dialog, the prestige of Nepal's school education system depends on the results of SLC/SEE. To achieve good results, the school teaching resources are insufficient, i.e., time, learning material, the physical infrastructure of the school, the learning environment, the student's background, etc. Therefore, directly practicing the final exam questions is the best solution to achieve a good result in the final exam. The good results of the final exam determine the school's quality, the mathematics teacher's dedication, and the student's learning capacity.

During my teaching years, for the 2008 batch of students, I did less practice regarding the final exam possible questions and focused more on teaching curriculum concepts, knowledge, and skills. The final exam results of that year went down quite a bit compared to previous results in mathematics. This scenario made me realize that it is not easy to maintain the prestige of a mathematics teacher without practicing and focusing on the final exam's questions. After this year, I continued to practice possible questions in the mathematical classroom.

Hence, I concluded that authoritarian teachers, guided mainly by technical interests, have some restrictions, assumptions, and values that restrict the learner's creativity, such as a controlled classroom environment where the learner cannot expose his ideas. However, a democratic (progressive) environment focuses on self-rule into reality (Osboron, 2018).

Nowadays, I realize that the result of a particular academic level is a contextual event. However, in Nepali society, it is everything. Therefore, a mathematics teacher from secondary school is compelled to focus their effort on achieving good results in SLC/SEE rather than skills, performance, etc.

From the above discussion, students were found to believe in practice methods for better performance in mathematics learning. When I was engaging the students in more and more mathematics practice in the classroom, I found that the school administration was happy with my job, and I was considered a model teacher. Therefore, I practiced this method in classroom activities every year without thinking about innovative teaching methods for the increment of pass rate of the students as well.

From the above anecdote/theme, I/we can conclude that our systems are guided by a result-oriented mindset rather than skill, performance, and long-life learning. "*Students are apt in tasks related to memorization and recall but are ineffective in skills requiring application or ability at a higher cognitive level*" (Education Review Office, 2011). This report also proves that such activities in mathematics classrooms could not promote a learner-friendly environment. I do not deny achieving results is also one dimension of learning, but the process of learning or pedagogy may cultivate a harmonious environment in the classroom. For this context, we may think differently inside the classroom to tackle the "*I Need Good Result in SLC"* rather than critical thinking and problem-solving skills. To achieve those skills, STEAM education is an education model based on a multidisciplinary learning approach. This model helps the learner to engage collaboratively for inquiry-based learning. Broadly, it emphasizes the contextuality rather than universality. So the students can identify reality and then construct knowledge along with creativity. STEAM is an approach to learning that empowers learners and prepares them to tackle complexity, change, and diversity. It also provides deeper concepts in specific areas (science/ mathematics/technology) as we seek twenty-first-century skills (Gogus, 2015).

Chant the Important Theorem Ditto no Alternate Idea: Pass the Final Exam

It could be any day of June 1998. The mathematics teacher attended in the class and asked about yesterday's homework, which was "*The angle at the center of the circle standing on a given arc is twice the angle at any point of the circle standing on the same arc."* He has asked us to spell that theorem because that theorem was asked in the SLC/SEE examination more than five times. However, many of us could not spell that theorem as he had told us. One of my friends asked him, "*Sir, how did we become so talented in geometry-related theorems? I have heard that some students get almost full marks in mathematics. How is it possible? Teachers and the whole*

school highly appreciate you as a good teacher. Will you please share your ideas of being such a mastermind in mathematics?" He put his questions to him innocently.

With a genuine smile, he replied, "*Mathematics is just a bundle of formulas. So, memorize them thoroughly and use them appropriately. That's it!*" He asked him again with a surprising voice, "*That's it!*" He replied, "*Yes. You just need to have a good brain to memorize all formulas ditto. And need to practice them again and again. You don't need to be creative.*" For his quires, he shared some of his specific tips to be followed in upcoming days in not only theorems but also in mathematical calculation too.

I thought of getting rid of this mathematics/geometry-related theorem anxiety during that time. For that, my senior's suggestion was the 'perfect medicine' for my mathematics sickness in the same line. So, immediately, I determined to follow his prescription. I still remember, on the same day, whilst returning home from school, I bought a few big-sized chart papers. I wrote all the formulas in big letters and used different colors to make them more attractive. After spending 2/3 hours, my formula chart was ready. I took it like a golden rule written tablet and pasted it on my room's wall. Every day, I started to look at them and chant those formulas in a loud voice frequently. From that day onwards, I started to consider *mathematics as a bundle of formulas, and memorization is the key to unfolding it.* Day by day, I memorized those formulas/theorems very strictly, so whenever the teacher asked the formula class, I used the first to answer his question. I started working on my rigorous practices of those various algorithmic problems until late at night and early in the morning. Gradually, my confidence level increased. My mathematics teacher noticed me, and my friends admired my formula memorization skills.

Now, my history was too problematic and rigorous. Similarly, the processes of various mathematical problems were rarely explained. I learned and understood from these daily "math problems" that math is about finding the answer. You need to focus on the product rather than the process. It doesn't matter if we learn these concepts, but by applying the formula and getting the answer. That's all. In this way, I concretized my belief system, asking what the answer is in mathematics. The question is, why and how is such an answer? This was a picture of the curriculum as "subject or content" or "targeted learning outcomes," as described by Schubert (1986). The source of the questions were textbooks and question banks.

In this regard, based on my experiences, I realize that cognition tends to attain knowledge through deductive reasoning in a linear way as a product of didactic pedagogy, thereby subordinating/neglecting the key role of insight and sense in the meaning-making process while teaching and learning of mathematics (I. M. Shrestha, personal communication, November 27, 2016; Shrestha et al., 2020). So, the cognitive domain is not only a sufficient part of teaching and learning. There must be an effective one as well. As Tanjung et al. (2020) through the affective domain, we deal with things emotionally, such as feelings, values, appreciation, enthusiasm, motivation, and attitudes" Hence, the affective domain has a crucial part in teaching and learning.

On the other hand, while promoting meaningful, authentic, and inclusive (Mathematics) education in Nepal, we need a real commitment to address it as contextual pedagogy is required, which helps them learn in their environment, transformative pedagogies applying different tools such as local arts and designs. The inclusive education program aims for comprehensive, quality education and skill-building of the children, and meaningful education seeks a pragmatic way of learning rather than chanting the theorem for the point of examination. Learning becomes long-lasting.

In addition, we have to reform the fragmented teaching-learning activities and promote the STEAM model. Then, not only mathematics but all disciplines can be reformed. Instead, teacher centralism, teaching curriculum, exam model, disciplinary egocentrism, and many more issues should be reformed to make a meaningful, authentic, and inclusive curriculum (of mathematics) in Nepal (Shrestha, 2022). Also, to promote meaningful, authentic, and inclusive education, we must adopt progressive pedagogy to foster transformative learning by placing imagination, intuition, and emotion at the heart of transformation (Kroth & Cranton, 2014). Then, we can feel/realize the meaningful, authentic, and inclusive education.

Key Message of the Chapter

This chapter begins with the title of "teacher as content transmitter" or a conventional pedagogue. I have shared my experiences from my life's teaching and learning phases through different genres. The representation of the conventional pedagogue in the teaching and learning field gave me a good experience. The main

interesting part of this chapter is what I faced and what I was forced to do during that time.

Another part of my experience was focused on my conventional teaching and learning in different schools, which brought out my experience as a rigid teacher and learner who only taught books, not the students. Those experiences of teaching and learning inside and outside of the classrooms presented as the transmitter teacher gave them only the theoretical knowledge in a controlled class environment. Finally, I realized that empowering mathematics pedagogues through STEAM education approaches is required to create a learning environment that empowers students to see themselves as capable and skilled mathematical thinkers within the broader context of STEAM education.

In this regard, based on my experiences, I realize that cognition tends to attain knowledge through deductive reasoning in a linear way as a product of didactic pedagogy, thereby subordinating/neglecting the key role of insight and sense in the meaning-making process while teaching and learning of mathematics (I. M. Shrestha, personal communication, November 27, 2016). So, the cognitive domain is insufficient for teaching and learning. There must be the affective domain as well. Through the affective domain, we deal with things emotionally, such as feelings, values, appreciation, enthusiasms, motivations, and attitudes

On the other hand, while promoting meaningful, authentic, and inclusive (Mathematics) education in Nepal, we need a real commitment to address it as contextual pedagogy is required, which helps them learn in their environment, transformative pedagogies applying different tools such as local arts and designs. The inclusive education program aims for comprehensive, quality education and skill-building of the children, and meaningful education seeks a pragmatic way of learning rather than chanting the theorem for the point of examination. Learning becomes long-lasting.

CHAPTER V
BECOMING AN EMPOWERING MATHEMATICS PEDAGOGUE THROUGH STEAM APPROACHES

In Chapter IV, I have presented my feelings and the lived experiences of teaching and learning as a mathematics teacher in different stages of my life from the perspectives of STEAM approaches. The practices and experiences of my teaching profession helped me as a symbolic teacher representing the content transmitter/conventional teacher. These narratives helped me to turn into another part of the teaching methods.

This chapter entails my experiences with the inspiring factors from my STEAM educational journey despite my absolutist teaching and learning journey by addressing the second research question. *How have I transformed into an empowering mathematics pedagogue from a conventional mathematics pedagogue using STEAM pedagogical approaches?*

Here, I have presented five narratives to solidify my second research question. My experiences as a *Personal/Educational Narrative, Professional Narrative, and Cultural/ Collaborative Narrative* regarding an empowering mathematics pedagogue through STEAM approaches.

My Way of Learning

It might be in January 2019; I took my bag and moved toward Kathmandu on a night bus for the written exam and interview for MPhil at Kathmandu University. The next day, I reached KU and sat for the written exam and then the interview. Then, I returned home and looked forward to the result. The result was published, and we stood on the pass list. After a few days, I joined the STEAM education program. Largely, I was unaware of the program, and we used to call the block mode students because we had to reach KU for a week every two months. We were not regular-mode students.

It might be the third week of January; I attended a weekly KU class program. I was from a pure mathematics background, but our work was on educational research, teaching methods and methodologies, educational dimensions, etc. I got puzzled and socked for a few days. When we have completed seven days of class, we return to the classroom with different educational papers and articles. Suddenly, after a few weeks,

the COVID-19 lockdown started, and then our classes were stopped. After a few weeks, KU started taking classes online through different platforms. When we joined the online platform, we read regularly about the subject matter and the perspective of STEAM education.

I started my regular engineering classes through the online platform, not only my MPhil classes. That helped me to handle the classroom using different ICT or technology inside the classroom. Then I came to realize that we teachers need different support either in technology or in pedagogies.

Moreover, I was curious to know different concepts in teaching and learning mathematics. So, I enrolled in the Kathmandu University MPhil program as a STEAM scholar. I have had a chance to realize the concepts and philosophies from the studied program. Different pedagogy and approaches inside the mathematics classes, other papers and articles, and interaction with professors, facilitators, and friends encouraged me to explore new ideas for teaching mathematics. Similarly, discussions with my friends also motivated parts of my learning stages.

Now, I want to share my one incident; I think we were in the middle of the first semester, and our professor had given us one activity to perform in schools or the community as per our project, then made a video and sent me the video link from YouTube. Then it made me very difficult to think. What project is suitable for me, and how can I implement it? Before that, I had not performed such activities. Fare is moving here and there. We have two weeks to submit the report.

I remembered one idea: as a STEAM scholar, I had to implement such a project in the mathematics classroom. That will be helpful to the teachers and the students as well.

Project theme: **Environmental Sustainability through a unitary method in grade seven.**

Outcomes of this project:

1. Students will be able to grasp basic concepts of unitary methods such as addition, subtraction, and ratio-proportion.
2. Students will be able to relate the mathematical problem (unitary method) with real-life situations, e.g., if one pocket of noodles costs Rs.10, then what may such five noodles cost?

3. Through this project work, students will be able to connect their ideas towards environmental sustainability and awareness, e.g., can you find what type of chemical can be used in noodles packet and how harmful to us?
4. Learners will be able to connect the ideas of interdisciplinary subjects to generate better creativity while learning unitary methods.

Duration: 4 periods with 5 students per group

Materials: Plastic covers such as noodles and biscuits (cardboard, colored paper, tape, scale, and rope) are available in the projected ground/place.

Activities (Based on specific theory/s):

In the first period:

1. Each group is given to collect noodles and biscuits covered from the separated areas from the ground with the different group leaders.
2. After collecting such covers, gather them in their own group and involve them in activities as leaders do.

In the second period:

3. Ask them how many covers you have collected today.
4. How many such covers can be collected after five days in such a way?
5. You have collected 80 covers in 40 minutes; how many can be collected in 1 minute? (less/more)? (You/teacher must demonstrate those covers to clarify the meaning of this question).
6. How many covers can be collected in 5 minutes? Inspect yourself and give the correct answer. (Give a chance to them to do them collaboratively).

In the third period:

7. Imagine that in the same tendency, if we leave those plastic materials on our earth, what harmful effect can be seen? Write any five effects of such materials in your diary individually and cooperate with your group leader (20 mins). (After that, the teacher will help make a list of effects on cardboard and explain them).
8. Can you make a vision of what would be the alternate idea for plastic use? And construct a prototype of such material, excluding plastic with a suitable design? (Give students 20 minutes to complete this task collaboratively).

In the fourth period:

9. Observe collaborative tasks, giving suitable suggestions by assisting and encouraging them to solve the mathematics, science, Nepali, social, and environment using real-life events.

Assessment

1. Make a vision to displace plastic pockets such as noodles and biscuits by using renewable substances with different designs and technology and submit it to your class teacher after one week.
2. If one group can collect 1/80 covers in 1 minute, find how many covers can be collected by such four groups in 1 minute.

Assessment Rubric:

Level of engagement in class	Listening/ questioning/ discussing	Behavior (Basically non-cognitive factors)	Preparation	Problem solving	Group work	Remarks
10	10	10	10	30	30	

Level of engagement in class- How is the learner performing his (own) ability towards project work?

Listening/Questioning/Discussing- How does the learner become conscious of L/Q/D?

Behavior – Behavior refers to non-cognitive factors (academic mindsets, social skills, academic perseverance, and learning strategies, which manifest through academic behaviors to predict academic performance) of the learner.

Preparation- How is he preparing for the project (subject matters)?

Problem-solving-This is a major part of the project. Primarily, we focus on performance, the synergy of the projects, and subject matters generating newer ideas. We see his skills to manifest problems towards solutions using different disciplines.

Group Work- Group work/collaboration is a necessary part of the project. So, we focused on his social skills and mindsets and discussed his project/skill.

STEAM Components

Science- Science may help them observe harmful chemicals in plastic substances and identify them.

Technology/Engineering- Identify the different models and investigate feasible solutions to control plastic items.

Art- Construct a prototype of such material, excluding plastic, with a suitable design.

Mathematics- Learn unitary method through using real-life context learner's (self).

Future Project:

Can you envision how we can protect our community through plastic materials? And develop a suitable prototype using paper to displace such pockets.

I have implemented this project in Motipur Higher Secondary School in Butwal; class seven-section 'A' students were involved in that project with a mathematics teacher. They find it very easy to know the different situations of mathematics and the sustainability of education.

Figure 5

Collaboration with Community School

(Sources: Self)

During the activities, I kept on interacting with them, and based on the interaction, I realized that they were able to conceptualize the unitary method and how we can make our surroundings clean and construct meanings from them. I was very happy that almost all the students were engaged in the activities. More so, while teaching the same chapter theoretically, I connected both procedural skills and conceptual knowledge of making the objects to find a unitary method. It was much easier for me to demonstrate different objects to conceptualize the unitary method, which based on my experience, most of the students wouldn't conceptualize easily while solving the problems just through figures.

Upon interaction, here is what they had to say: *"It was an awesome experience, Sir. We never got any chance of learning mathematics practically before you came to this school. Thanks for teaching us, sir! You have done for us. We are grateful to you, Sir!*"

"It helped me to find the concept of divide and multiplication on unitary method."

"*Wow! It was wonderful having got practical experience in mathematics."*

"*We had learned that if the quantity feels more, use multiply, and feel less quantity, use divide, sir."*

Really, I feel proud to be a student of STEAM as I learned the different dimensions of teaching and learning. It took four periods for me, with the mathematics teacher, to handle this project, where 35 students were divided into five subgroups. First, I instructed all the teachers, with the head teacher, about STEAM-based learning. Then the head teacher offered me such training and different projects.

After the project, I requested the mathematics teacher, Gita Acharya Madam, to help and fill out the assessment rubric as it was given in the project. We got enthusiasm from the learners and the whole school team as well. Finally, I have suggested that all the students accomplish this future project with their class teacher. Now, I agree with (Le, 2018) "The practical side of Project Based Learning (PBL) will be helped in enhancing students' academic achievements, developing social skills, and promoting motivation and active learning". I don't claim that other methods are the ruin methods; they are also important in teaching and learning, but this type of project activity provokes the learner's insights towards the subject matter.

Project-based education is a student-centric learning approach. Broadly, it is guided by three constructivist principles: learning in a specific context, being actively involved, and believing that knowledge is constructed through the socializing process (interaction and understanding) (Kokotsaki et al., 2016). Through this learning process, learners get more chances to construct knowledge by involving themselves in a real-world problem. This is too important in my research because Project-based learning is correlated to STEM (Science, Technology, Engineering, and Mathematics) curriculum directed to gain in terms of pleasure, engagement with the project, and the skill to combine theory and practice outstandingly (Kokotsaki et al., 2016).

My Professional Way of Learning (Professional Narrative)

Still, I remembered it may be 2014 AD, and my bachelor batchmate friend had completed his master's in mathematics and joined the reputed private college in Butwal; I asked him, "How are your days going on master?" He used to say that "Ratvari ghokeyo diusvari khokeyo". The literal meaning of this sentence is that there is *no need to understand mathematics all night or the next day.* Furthermore, if you solve the problem carefully the board, students tell you that you a talented teacher, and then students do not question more, but you have to write on the board nonstop. These guidelines and mindsets were developing in my mind.

Again, I want to remember my early teaching career, which started in June 2001, the first time I entered grade three as a mathematics teacher. At that time, I had

some assumptions, values, and teaching methods that differed from what I have now. At that time, I was supposed to keep students silent. Students had to copy the texts as I wrote on the board. There was a provision to sit four students on each bench, and almost every student was placed on the first bench.

Furthermore, academically weak students could not benefit from academically bright students because my mindset was fully guided by conventional thought as the learning process is cultural reproduction (Schubert, 1986), which means that I have faced in my learning periphery that I had been using (sensitizationally). The weak student did not care about either the educational process or the extra activities process. I have continued this educational process (conventional method) for a long period. During that period, I have never envisioned a democratic classroom to promote ethical responsibility with a more participative, supportive, and opportunity-based approach inside the classroom (Dewey, 1923). It emphasizes education as the training of the mind rather than education as reconstruction (Dewey, 1996).

When I completed my master's degree, I left school-level teaching and joined different colleges. After joining the higher-level class, I realized that a conventional classroom cannot create the learner's creativity. This is only fit for a rote recall culture. Along with that higher class (after my master’s degree), I have been feeling how rigorous the process I had adopted in the teaching-learning activities was because they neither got a chance to ask the questions in class well nor got an opportunity to use their creative mind in the meaning-making process. Now, I want to remember one example of my conventional classroom: one of my students who had fainted in the classroom after my punishment, where s/he could not recall trigonometric ratio formulas.

After that incident, I thought about changing my methods inside the classroom. I realized that I should adopt a frank environment (unknowingly democratic) by supporting students in different project-based learning programs on the subject matter to empower my students. I have distributed authority and responsibility among the students to organize different educational programs as far as possible. I have created a comfortable environment within the classroom so that the students can raise their voices in class independently. After that, I felt that learning is a social process that requires full cognitive development with social interaction (Dewey, 1923). Hence, social interaction (collaborative learning) is too essential to promote creativity and a connected network of learning. As a result, democracy can

be seen inside the classroom. Not only does democracy help inside the classroom to the learner but it also helps in the holistic development of learners in creativity, critical thinking, skilling on collaborative tasks, and many more I realized.

Hence, my previous authoritarian method was guided by my convictions (sensitization), which made me only conscious of how to make class control. How can students complete the course on time and increase their pass rate? However, the democratic method helped me to learn that learning is a social process. That helps the learner empower the student's ability to learn about the multiple perspectives of controversial issues.

I have been adapting that method in my classroom; in the 2020 intake program, I got a chance to join Kathmandu University in the School of Education as a STEAM scholar. I learned the different approaches and philosophies regarding teaching mathematics and the relevancy of a holistic approach in the education system. Those made me think and rethink it, and I kept practicing in my profession under different conditions.

As per the structure of my proposal, in chapter V, my second research question is, "How have I been becoming an empowering mathematics pedagogue through STEAM education approaches?" I explore how I realized the meaningful aspects of empowering pedagogues as a mathematics teacher and assimilating conventional and empowering mathematics pedagogues through the STEAM approach.

Unknowingly, I was motivated toward the mathematics-related problem that must be illustrated through geometrical lenses. Meantime, I remembered that an incident. It could be the day of April 2017; in the morning shift, I entered the Civil Engineering class section 'L' and reviewed the previous day's topic *sphere and the plan*, then asked them about yesterday's homework assignment. However, most students had not completed the task, and those who had done that assignment were copied from different Indian writers' books. However, one of my brilliant students, Bishal, submitted his assignment differently than had been taught in the classroom. He completed his task completely by drawing at every step of the problem and using different artifacts. Such as apples and knives/blades, where apples are spheres and blades are planes, are demonstrated in his copy. I thought that I had been teaching the same topic for six years, but I could not think or rethink the use of local materials inside the engineering mathematics classroom.

That student's learning process touched my mind and brought many events with different reflections on my teaching and learning journey. Indeed, I felt that reflective practice is too essential to modify or cope with the different situations throughout one's professional life to revise the frame of structural references of thinking, beliefs, and actions (Taylor, 2017). But I realized that I could not do it on time. Reflective practice is also an approach that helps professionals realize how they use knowledge in their field and are involved in critical and deliberate inquiry into professional practice to achieve a deeper understanding of the phenomenon.

The next day, I took those assignment copies to the classroom and distributed them individually with their feedback, which aligned with my teaching tendencies. At last, I visited Bishal and asked about my methods and pedagogy. He suggested to me that your teaching and delivery style are too interesting, sir, but one thing is lacking. I questioned, what Bishal? Connection with different contexts and geometrical figures, sir.

Again, that touched me: how can I do best in the teaching-learning field of mathematics? How can I deliver my knowledge as a good mathematics pedagogue? How can I change/ shape my pedagogical practices from conventional to progressive? For a few days, it frustrated me and caused tension. For the next week, I tried my best for the new question on spheres and planes with different arts and artifacts. When I entered the classroom, I had one small ball and a plate to demonstrate the sphere and the plane and how the plane and sphere touch each other.

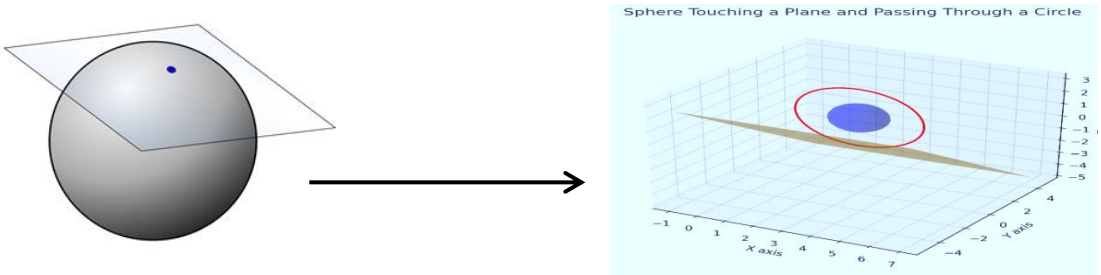
Dear students today we will read sphere differently as we did the day before yesterday yes! Today's question is: *Find the equation of the sphere which passes through the circle,* $x^2+y^2+z^2$ *-6x-2z+5=0, y=0, and touches the plane 3y+4z+5=0.*

Solution: Given circle is**,** $x^2+y^2+z^2$ -6x-2z+5=0, y=0 ……i)

So, the equation of Sphere is $x^2+y^2+z^2$ -6x-2z+5+λy=0……ii)

Figure 6

Concepts on Sphere (Sources Google)



Explanation of graph

Here's the graph showing the sphere, the plane, and the circle:

- The **blue surface** represents the sphere.
- The **gray surface** represents the plane 3y+4z+5=0.
- The **red curve** represents the circle $x^2+z^2-6x-2z+5=0$, lying in the plane y=0.

This visualization helps illustrate how the sphere touches the plane and passes through the circle.

Hence, clearly the center of the sphere ii) is, $(\frac{-6}{-2}, \frac{-\lambda}{-2}, \frac{-2}{-2}) = (3, \frac{\lambda}{2}, 1)$

And the radius of the sphere ii) is,

$$r = \sqrt{9 + 1 + (\frac{-\lambda}{2})^2 - 5} = \sqrt{5 + \frac{\lambda^2}{4}}$$

since, the perpendicular length from the center to the plane 3y+4z+5=0 equals the sphere's radius. So,

$$\frac{0x2+3x\left(-\frac{\lambda}{2}\right)+4x1+5}{\sqrt{3^2+4^2}} = \sqrt{5 + \frac{\lambda^2}{4}}$$

Squaring on both sides and solving the equation we get the result, λ =-4, $\frac{-11}{4}$

Then the required equation of the sphere i) becomes

$x^2+y^2+z^2$-6x-2z+5-4y=0 ⇒ $x^2+y^2+z^2$-6x-4y-2z+5=0 and

$x^2+y^2+z^2$-6x-$\frac{11}{4}$y+5=0; hence, this is the required result.

I taught ten such classes using these methods on different topics using different figures and artifacts. Most of the lazy students in the class also used to seem to question mathematics periods. When I took a test with different new questions, they also performed best. After that, I realized I had to change my teaching style and pedagogies in the classroom. Also, in the semester-end examination, they performed well, as did the previous results of my subject. Still, I remember that it was my great breakthrough to know myself first in the pedagogical voyage.

Mezirow (1989) supports me in critical reflection and review because it could transform understanding. So, it is the gateway to transformative learning as well. Hence, this scenario concluded that the phenomenon could not be transformed without becoming a critical/ conscious learner/educator. I have used real artifacts and the three-dimensional graph to evaluate the solution of the sphere. When I used that graph and artifacts, students became interested in geometry and sketching software. I

realized that small changes in pedagogy do change the learning capacity of the learner. So, to foster creativity, the STEAM environment is a promising starting point for the quest to promote motivation and creativity in educational settings (Conradty & Bogner, 2019). Hence, I realized that moving on to the new journey of life/educational contest, we must cross the previous behavioral thoughts. That's why, through the lens of critical pedagogy, I always find myself as a critical teacher prepared to empower myself and my students during my pedagogical practices, thereby challenging my students' status quo in the teaching-learning process of mathematics.

Then, I concluded that we could not address our twenty-first century demanded education for our graduates by emphasizing theoretical rather than skill-oriented knowledge. Still, we promote unskilled graduates through our education system and its policy. Hence, from the learning scenario of our schools, colleges, and universities, we are producing our graduates only for certification rather than required skills.

After six months of study of STEAM education and related papers, videos of the different countries about STEAM made me think of becoming an institutional leader. From my MPhil study, I learned about STEAM education and its dimensions. As I know, STEAM education is an education model based on a multidisciplinary learning approach. This model helps the learner to engage collaboratively for inquiry-based learning. Primarily, it emphasizes the contextuality rather than universality. So the students can identify reality and then construct knowledge along with creativity. STEAM is an approach to learning that empowers learners and prepares them to tackle the phenomena of complexity, change, and diversity. It also provides deeper concepts in specific areas (science/ mathematics/technology) as we seek twenty-first-century skills (Gogus, 2015). So, STEAM is an emerging model for twenty-first-century education to address local and global issues for the labor market or innovation. So, I choose this work to transform our society through STEAM education to prepare skillful citizens per the demands of local and global contexts.

I believe educational transformation is possible when the students are ruled by skillful knowledge. Furthermore, authentic, meaningful, and inclusive learning helps educational transformation. Here, authentic learning is where students discuss, explore, construct concepts, and make relations about the given problem. So, largely authentic learning is guided by constructivist theory. Also, authentic learning is an

interdisciplinary primarily approaches. Similarly, to attempt meaningful learning, we must address the many aspects, firstly contextualize (localize the knowledge through culture, environment, etc.) the subject per the nation's demand, transformative learning approach, inquiry-based learning model, etc.

My Empowering Culture of Teaching

No science and mathematics teachers applied when the vacancy was announced six times. Will you please explain how STEAM approaches can be implemented in my school without science and mathematics teachers?

After my first face-to-face class at KU, I returned for the morning class shift at college. At that time, one of my close friends said, *"Haa…..why did you join STEAM education in MPhil? Did you leave pure math? There are only teaching methods and methodologies with different philosophies in the STEAM curriculum. There is no pure mathematics.*

Furthermore, I think that is not the relevant teaching method in the separate subject learning era." I did not give any reply to his question. I thought to myself, why was he saying that? Also, I thought that was his view, but reality was different. The sense of that saying was the dominant view of the subject over the subject. That is a symbol of the dominant culture in our society.

I learned mathematics through a rigorous process of rote recall and a largely iterative learning process. I read mathematics, but I was not aware of how mathematics germinates. This means that we do not know the philosophy of mathematics. So, what type of culture are we constructing? Such kinds of questions were raised in my mind. So, this chapter entails the cultural and collaborative dimensions of my research.

It could be the day of January 2020 A.D.; we were at the top of the old academic building of the School of Education in KU. Our professors suggested us to read the bundles of papers. One of the papers compelled me to shift my thinking paradigm: "Why is a STEAM curriculum perspective crucial to the 21st century (Taylor, 2016)?"

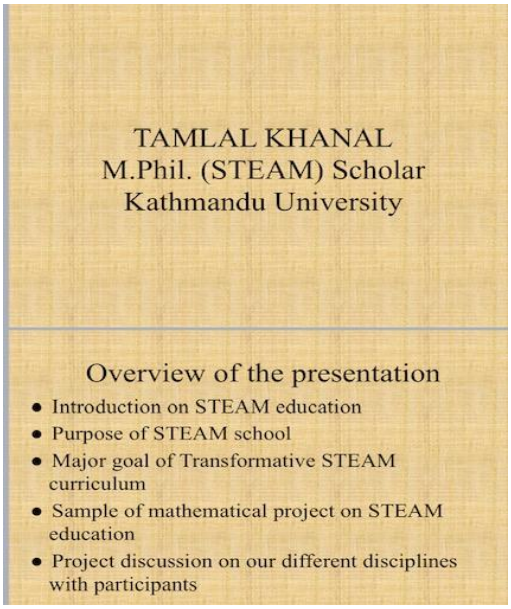
I had heard that our Nepali or local learning methods and methodologies were phased out or ruined and uninterested. So, we have to reach out to global learning methods and methodologies. After taking different concepts from the STEAM papers, I deny that global context is superior or meaningful to local context.

I remember one incident that could be the day of August 2022. I was offered a rural municipality of Arghakhanchi for a three-day training session for math and science teachers about teaching pedagogy. There were twenty-seven teacher participants in the training. The session was distributed in two parts. My session was related to pedagogy and theory and practice in science education. As a STEAM scholar, I had the materials about STEAM education and its philosophy. In the first session, I took a class about STEAM education, the STEAM approach, and its practices in the world and Nepal. All the participants were spellbound about my session because that was a new dimension for most teachers.

I was clarifying the session as shown in my presentation.

Figure 7

Presentation Synopsis of Training (Sources Self)



Interestingly, all the young teachers raised their voices with different perspectives on STEAM pedagogy. After the major goal of the transformative STEAM education curriculum, *the ice break session, I requested them to talk about implementation in your organization; approximately nine* teachers said it is a difficult concept to implement in our school.

I asked them why is this difficult sir? One head teacher said *that we don't have such training and materials or qualified teachers. Furthermore, we don't have science and mathematics teachers while advertising four or five times. To implement this project, governmental rules and policies must change, sir. This is my individual opinion, sir. I don't mind. Okay!* I laughed…….haaaa… and said thank you for your opinion.

Next, the participant raises their hand and *sir, is it possible to teach the whole classroom? And we are facing difficulty in teaching subject-centric methods, but you are saying multidisciplinary is possible, sir? Do we get a sample plan?* I replied to him, you are right! Today, in the last session, we will all be involved in such a project. Others were waiting for my remaining presentation.

Then, I started the next session. Implementing the project was easy because all the teachers were from science/math backgrounds. Then, after the short break, I

started my *major goal of transformative STEAM education. M*ost of the teachers looked very interesting and were asked questions about it. I added that, according to (Taylor & Taylor, 2019), transformative STEAM education turns to **g**enerate synergetic spaces for the holistic growth of the learners by integrating five ways of knowing: cultural-self knowing, relational knowing, critical knowing, visionary and ethical knowing, and knowing in action. I added that you could also see the following points on my slide. Students who participate in STEAM learning could get different conditions of learning, as:

- Think outside the box.
- Feel safe to express innovative and creative ideas.
- Feel comfortable doing hands-on learning.
- Take ownership of their learning.
- Work collaboratively with others.
- Understand how science, math, the arts, Engineering, and technology work together.

When I explained those points, interestingly, they became eager to know the approach to teaching and learning science and mathematics through the STEAM approach. Then, I presented the theme of the project as,

"Conceptualizing the Profit and Loss using STEAM education approach."

Theme: Profit and Loss:

Duration: Four class periods (45 minutes each)

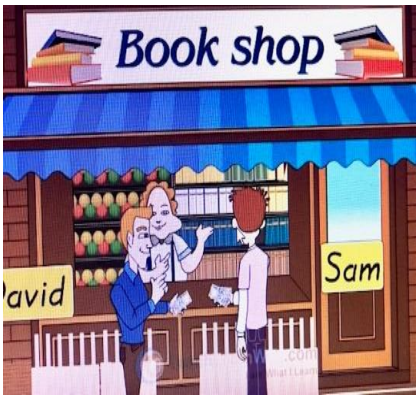
Learning Outcomes: (15 Minutes)

- Introduce the idea by discussing small business, like a grocery shop
- Ask the students to think about how a shopkeeper buys goods (C.P.) and sells them (S.P.), then introduce the terms profit and loss.

Apply mathematical concepts to real-world situations.

Figure 8

Interactive Learning (Sources Google)



- Integrate technology, engineering, art, and science to enhance understanding.

Materials Needed:

- Computers/tablets with internet access
- Graph paper and colored pencils

Spreadsheet software (e.g., Excel, Google Sheets)

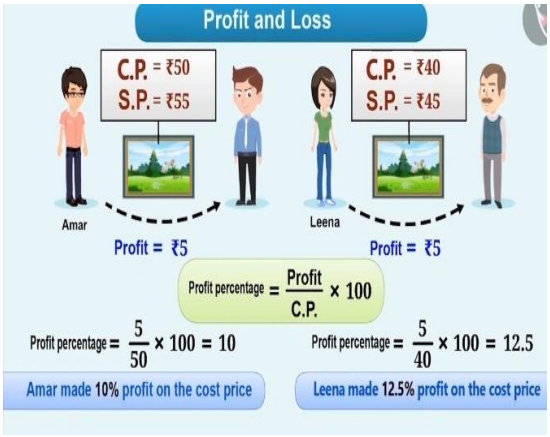
Calculators

- Projector and screen
- Sample products for mock sales
- Art supplies for creating posters

Introduction: (15 Minutes)

- Begin with a discussion on what students know about profit and loss. Use everyday examples, like selling or buying materials for their home supplies.
- Introduce key terms: cost price, selling price, profit, and loss.

Figure 9.
Learning through market analysis (Sources Google)



Concept Explanation: (15 Minutes)

- Explain the formulas for calculating profit and loss:

❖ Profit = Selling Price - Cost Price

❖ Loss = Cost Price - Selling Price

- Use visual aids (charts, graphs) to illustrate these concepts.

Activities (Based on specific theory/s):

In the second period:

1. Create a mock market in the classroom with four groups of buyers and sellers of different goods. The first group – the stationery Shop
   The second group – Fruits Shop
   The third group – Bakery Shop
   The fourth group, Chat-Pat Shop, and the remaining four groups are ready to buy different items by giving some money as they require (there may be four to five persons in a group with a team leader).
2. The remaining four groups of students make ready as they desire to buy different goods.
3. Leave them nearly thirty minutes to buy and sell the goods and let them (the team leader) note down the activities they did, both buyer and seller, in the thirty minutes.

In the third period:

4 Collect students in two groups on two sides of the classroom as buyer and seller.

5 Take information from the students and leaders for half an hour.

6 Give a chance to the group leaders from both sides to give their information.

7 Firstly, how much would the cost be paid to buy one copy for the mock market? What price did they sell per copy there? Similarly, the teacher makes them clear about their different shops.

8 In a similar manner, conclude how we get profit and how we get loss. Similarly, we may use profit percent and loss percent as their level of learning.

In the fourth period:

Relate the above project to the questions. Such as taking the above information and asking who the seller of copies is. Yes, tell me, what was the cost price of a copy? Yes, that is the cost price (C.P.) of a copy. And the next group who bought that copy? At what price did you buy it? This is the selling price (S.P.), ok! Ok, let's take just the same example.

You know, from the above data, Ramesh (Seller) bought a copy for Rs. 50, and he sold that copy for Rs. 55. Then, is there a profit or loss? How do you claim that it is profit? Yes, C.P. < S.P. What condition is required for the loss? Could you imagine? Similarly, can you find the profit percentage?

Observe that collaborative tasks, giving suitable suggestions by assisting and encouraging them to solve the mathematics, science, Nepali, social, and environment using real-life events.

Assessment

1. Make a business plan/vision by discussing your group to promote hands-on business in your area using different designs and technologies and find a tentative profit of one year. Then, submit it to your math teacher.
2. If one group sold some items of books at Rs.23, 750 those book items were bought at Rs 24,500. Does this transaction give profit? If not, why? How can you make this transaction profitable?

Assessment Rubric:

Level of engagement in class	Listening/ questioning /discussing	Behavior	Preparation	Problem solving	Group work	Remarks
10	10	10	10	30	30	

Level of engagement in class- How is the learner performing his (own) ability towards project work?

Listening/Questioning/Discussing- How does the learner become conscious of L/Q/D?

Behavior – Behavior refers to non-cognitive factors (academic mindsets, social skills, academic perseverance, and learning strategies, which manifest through academic behaviors to predict academic performance) of the learner.

Preparation- How he is preparing for the project (subject matters).

Problem-solving-This is a significant part of the project. Primarily, we focus on performance, the synergy of the projects, and subject matters generating newer ideas. We see his/her skills to manifest problems towards solutions using different disciplines.

Group Work- Group work/collaboration is necessary for the project. So, we focused on his social skills and mindsets and discussed his project/skill.

STEAM Components

1. Science

- Focus: Use scientific principles to explore natural phenomena.
- Example: When teaching about profit and loss, students can conduct experiments to understand customers' perceptions and the effects of costs.

2. Mathematics

- Focus: Apply mathematical concepts to analyze data, make predictions, and solve problems.
- Example: Calculate the costs of goods, set selling prices, and determine profit margins. Also, students can use graphs and charts to represent and forecast profit data.

3. Engineering

- Focus: Design and build solutions to real-world problems using engineering principles.

- Example: Students could design an outline of the shop to maximize customer flow, display products effectively, and minimize costs

4. Technology

- Focus: Use technology tools to gather, analyze, and present data or create solutions.
- Example: Students might use coding software to simulate sales scenarios and create digital marketing campaigns to predict profits and losses.

5. Art

- Focus: Use a creative expression to transfer ideas and enhance understanding of the business.
- Example: Students can create visual representations of branding materials that appeal to the target market, such as logos and product packaging. Create visual displays and advertisements that attract customers to the desired business.

Most teachers seemed very happy when I entered the project presentation discussion session. Some were in a hurry to ask questions about the STEAM approach. Can you apply this to our context, where we lack science and mathematics teachers now? Most teachers were happy to see this type of project to tackle mathematics. However, some teachers disagreed with the availability of mathematics and science teachers in government schools of Nepal, who were almost seniors with more than 25 years of service teachers.

More than fourteen young teachers in training strongly agreed with the STEAM project and its validity in teaching and learning in the 21st century. I got that most of them were aware of 21st-century skills as well. From there, I felt that the mindset of the teachers depends upon their age factor as "this work suggests that adolescents' mindsets can be lastingly changed which can help them to better cope with socially adverse conditions (Bernecker & Job, 2019)".

The young and dynamic teacher *said that it was a great sharing, sir, because to date, we have not gotten that chance. How did the learner become happy? However, my methods are also teacher-centric. You have given us the chance to change at least the type of project we can conduct while introducing our students to a new chapter of the book. The students would realize the real-life situation of abstract mathematics. So, I would make the same STEAM approach plan for every topic. If I have problems, I will consult with you; thank you for this presentation.* That means

that most teachers are also trying to change their learning culture and systems. Also, most teachers argue with me about how we can teach them culture (largely moral) because the new generation neglects such culture and humanities, for this spiritual knowing must be added to our curriculum, sir. I added that, yes! This is also the one aspect of teaching and learning because students must develop such soft skills from the education.

Then, I added that spiritual knowing helps the learner build individual responsibility regarding values, feelings, compassion, and humility (Dei, 2002). So, the spiritual perspective is to promote the critical education system through different pedagogical approaches. The main objectives of transformative education are fostering transformative learning by placing imagination, intuition, and emotion at the heart of transformation (Kroth & Cranton, 2014) so that pedagogy will look like a transformative agency to make a difference for individuals, organizations, and society as we are doing. So, I got the point that to reach transformation, a single dimension cannot work at all; we need multidisciplinary (approach) pedagogical practices. The multidimensional perspectives promote the holistic development of self and others (nature).

So, for the sustainability of the planet, we have to educate our children (differently) in a multi-disciplinary way (STEAM) or make synergy with different disciplines emphasizing an empathetic dimension (adding spirituality). Similarly, for the focus of climate crisis, global warming, and loss of bio-cultural diversity, we have to educate our children differently as we are educating. Those different approaches are multidisciplinary, transdisciplinary, or interdisciplinary (i.e., connectedness) to assist the learner in the prolonged engagement towards the real-life problem. As well as we learned to develop the model of a multidisciplinary learning approach in mathematics or science and society. Hence, I learned that holism, or the integral perspective, is essential in transforming spirituality.

We were in the review session of the presentation. Then, I added some remarks to the STEAM approach in mathematics and its benefits and international practices; STEAM strategies are important for ‘learning by doing’ experiences for current and pre-service teacher education (Hunter-Doniger, 2018).

So, the journey of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education has been deeply shaped by broader cultural and societal aspects. Integrating STEAM approaches to education enhances the learning

experience and aligns with the cultural and societal values that drive educational policies and practices. This STEAM pedagogy explores the cultural relevance of STEAM education, the impact of educational policies, and the role of cultural values and norms in shaping our teaching practices.

Most of them agreed about the STEAM pedagogy and agree to apply on their classroom differently as far as possible. They agree that there is no need for sophisticated infrastructure; only we need the mindset to change the classroom pedagogy and the real context of our surroundings.

No science and mathematics teachers applied when the vacancy was announced six times. Please explain how STEAM approaches can be implemented in my school without a science and mathematics teacher.

One head teacher questioned me while I was delivering the importance and application of STEAM education in the first training session. They are also convinced that there is no need for more infrastructures to apply this pedagogy; general teachers may also apply it. I concluded my final remarks that the integrated curriculum (STEAM) is to assist students in improving their learning performance and engagement to better prepare graduates for real-world problem-solving challenges (Guy, 2013).

My Collaborative Teaching for Meaningful Mathematics Learning

It may be January 2019; I took my bag and moved towards Kathmandu on a night bus for the written exam and interview for the MPhil at Kathmandu University. The next day, I reached KU and sat on a written exam and an interview. Then I return at home and look forward to the result. The result has been published, and we stood on the pass list. After a few days, I joined the STEAM education program. Largely, I was unaware of the program, and we used to call the block mode students because we had to reach KU for a week every two months. We were not regular-mode students.

It may be the third week of January; I attended a weekly KU class program. I was from a pure mathematics background, but our work was on educational research, teaching methods and methodologies, educational dimensions, etc. I got puzzled and socked for a few days. After completing seven days of class, we return from there with different educational papers and articles. Suddenly, after a few weeks, the COVID-19 lockdown started, and then our classes were stopped. After a few weeks, KU started online classes through different online platforms. When we joined the

online platform, we read regularly about the subject matter and the perspective of STEAM education.

I started my regular engineering classes through the online platform, not only my MPhil classes. That helped me to handle the classroom using different ICT or technology inside the classroom. Then I came to realize that we teachers need different support either in technology or in pedagogies.

Moreover, I was curious to know different concepts in teaching and learning mathematics. So, I enrolled in the Kathmandu University MPhil program as a STEAM scholar. I have had a chance to realize the concepts and philosophies from the studied program. Different pedagogy and approaches inside the mathematics classes, different papers and articles, and interaction with professors, facilitators, and friends encouraged me to explore new ideas for teaching mathematics. Similarly, discussions with my friends also motivated parts of my learning stages.

I want to share my one incident; we were in the middle of the first semester, and the professor gave us one activity to perform in schools or the community as per our project. Then, we had to make a video and send a video link from YouTube after installing it on YouTube. Then, it made it very difficult to think. What project is suitable for me, and how can I implement it? Before that, I had not performed such activities. We have two weeks to submit the report. That concept gave me a key basis for changing my thinking in teaching and learning. Therefore, I began teaching my students from 'out of the box' and encouraged them to link mathematics to their everyday activities through cooperative and collaborative mathematics learning in the classroom. My students began to taste the flavor of the deductive method and the inductive method of learning. Gradually, they began to practice real-life situation problems, escaping them from the routine problems. Hence, they began to link academic mathematics to their day-to-day activities and cultural practices as much as possible. Once, I designed a project work for Grade XI on "Contextualization of Mathematics Education."

I remembered one idea: as a STEAM scholar, I must implement such project in the mathematics classroom. I thought, that will be helpful to the teachers and the students as well.

Topic: Application of Integration

"*How do you find the area of the irregular plot (using the integration method)?"*

Objectives:

1. Students will be able to select the respective limits by fixing the center of that irregular plot.
2. Students will be able to trace upper-curve and lower-curve concepts.
3. Students will be able to put those limits as required as the question
4. Students can select the surface of an irregular plot/ field.

Time: Approximately it may take One hour to deliver the concept ultimately.

Materials: Especially cardboard, different colors of threats, glue sticks to attach threats, scissors, and scales.

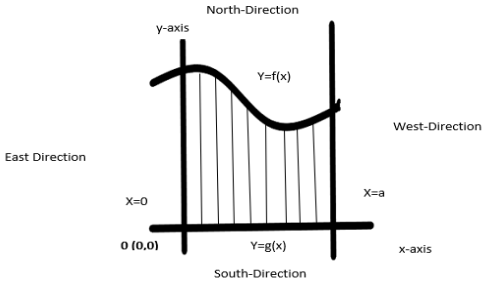
Form of Art used in this learning:

In this learning process, I am trying to incorporate the idea of art *as a storytelling method* because that story may motivate them to be active and curious about the problem. Through this storytelling, learners easily can assimilate that problem and help to cope with the situation.

Theoretical Perspective:

In this context, *social constructivism theory* is relevant because it emphasizes the importance of culture and context in understanding societal events and creating knowledge based on that understanding. Mathematics learning is also a socializing process. There is mathematics in our every cultural diversity. So, we learn the major abstract form of mathematics from our culture and society. For instance, to deliver the concepts of numbers to the child, we must show the rigid objects from his surroundings rather than direct rote recall. As my today topic for class eleven mathematics is finding the area of a plot under the curve, I am trying to assimilate this topic as our social issue of land because this type of social context/situation helps them perceive and solve the problem of mathematics. Hence, social constructivism may be a good theoretical lance.

Details of activities: Deliver the abstract ideas about the integration application and select the storytelling method. That will help the



learner to consolidate their ideas about the given topic. To make a solid concept of the following figure, I tell a story to them and continue my activities; a clever land broker has a big plot of field. However, he was unaware of the area of his field/plot. One day, he thought about identifying the area of his field. He tried to find the area himself, but he could not do it because it was not regular in shape, and he called the surveyor to find the area of his field. The surveyor asked for the details of his plot, and the broker said that *"there is a 20 ft road in the east, drainage pipe in the west, Alka hospital in the north, and public school in the south"*. Hence, the surveyor found that;

Upper boundary (upper curve) = Public School, y = f(x)

Lower boundary (lower curve) = Alka Hospital, y = g(x)

East boundary = 20 ft road, x = 0, origin

West boundary = drainage pipe, x = a, straight line.

The cleaver land broker was watching that idea of the engineer. The surveyor found that the calculated area of the irregular shape figure is: east boundary to west boundary and upper boundary minus lower boundary (in Nepali, we say that Charkilla) i.e., $\int_{east\ boundary}^{west\ boundary}(Upper\ boundary\ -\ Lower\ boundary)$ = $\int_0^a [f(x) - g(x)]$ dx is the required red area bounded from four sides. Where, dx is the limit of the x-axis. Finally, he learned that idea as well.

Assessment activities: Generally, there are two types of questions, limited to the x-axis or the y-axis. For a numerically different assignment, those two questions may be asked, and the figure is compulsory to know the exact area of the plot. So, a figure is necessary. So, the assessment rubric may be constructed as

Questions	Drawing	Fixing limits	Process	Remarks
Different two questions	Max. 15%	Max. 15%	20%	Total- 50%

When I applied this project in the classroom, teaching most students, they told me *today we felt mathematics, sir!* One student told me that *no one told us mathematics can also be done with project methods, sir! Sir, the same method must be adapted for every chapter of mathematics. We learned more in mathematics the first time.* That made me question why I/we have been promoting largely the cognitive part of the learning rather than the affective part. Most of the students are enjoying the STEAM project method in mathematics learning because they may know the real-life meaning of the integration in mathematics. They also knew that we could find the

area through the integration method of irregular plots. So, integration has wide applications in engineering as well. If they knew that dimension, they may get insight and question themselves about such conditions.

In this regard, I have selected Technology and Art as my STEAM philosophy because both are the heart of inquiry-based learning activities where. Art has a way of capturing the essence of an experience of the learner or designer, and Technology is such a tool in the learning process; it engages the learner with deep cognition with silent manner. Also, I found that every person is profoundly relying on others and on society at large for existence and development, including one's agency. Where an agency is a Transformative Activist Stance (TAS), somehow, it inherently "belongs" to an individual. Rather than enhance the quality of learning, we have to emphasize classroom teaching by *integrating images and art with interactive notebooks and photo narratives*. Hence, I found John Dewey's idea still relevant for inquiry-based learning; he kept the three points for inquiry-based learning as observation of the surroundings, differences of empirical knowledge with existing knowledge, and the judgment of both the knowledge. Hence, the STEAM philosophy largely believes in pragmatic, transformative, collaborative, and inquiry-based learning.

Nearly, I have spent more than two decades of my time in the teaching profession conducting teaching and learning in a parallel way. This means that most of my precious time was spent on teaching and learning activities, so I selected the education field beyond the scope of pure mathematics. Furthermore, STEAM education is the new approach to learning in our context in Nepal, so if I could do something here through STEAM education, I hope that the coming generation will be able to encounter different problems such as environmental, biological, and many more. So, I have changed my perspective on teaching and learning. So, the main purpose of transforming my perspective towards STEAM education is to enhance the education sector (existing learning system) towards inquiry-based skillful learning, especially in mathematics education.

When, I got an opportunity to enroll in Kathmandu University for my MPhil in the STEAM education program. My belief systems were challenged, and I envision the STEAM approach to displace the "chalk and talk" pedagogy and embrace new scientific methods as student-centric, collaborative, and inquiry-based learning pedagogies. My learning journey as a STEAM scholar has helped me learn about the importance of this multidisciplinary approach in pedagogical practices. So, a unified

curriculum (STEAM) aims to assist students in changing their learning performance and engagement and prepare graduates for real-world problem-solving challenges (Guy, 2013).

I realized from my long learning and teaching journey that the conventional (largely subject-centric pedagogy) teaching promotes learners' anxieties and deprives their hidden skills. In this regard, I have decided to conduct a research study on critically re/examining or reflecting on my conventional/progressive teaching pedagogies. Through the emerging STEAM approach, I am trying to transform from a traditional mathematics pedagogue to a progressive (empowering) mathematics pedagogue.

Key Message of the Chapter

I have tried to change my perception as well as a mindset towards my teaching and learning mathematics as a conventional (mainly promoting rote recall mechanistic learning in every classroom) pedagogue to an empowering mathematics pedagogue (as a STEAM implementor) through the different projects presenting or facilitating in own my classroom or the teachers training as well. That made me confident to apply to project-based mathematics classes. I have selected Technology and Art as my STEAM philosophy because both are the heart of inquiry-based learning activities; where art has a way of capturing the essence of an experience of the learner or designer, and Technology is such a tool in the learning process; it engages the learner with deep cognition with silent manner. Also, I found that every person is profoundly relying on others and society at large for existence and development, including one's agency. Where an agency is a Transformative Activist Stance (TAS), somehow, it inherently "belongs" to an individual. Rather than enhance the quality of learning, we have to emphasize classroom teaching by *integrating images and art with interactive notebooks and photo narratives*. Hence, I found John Dewey's idea still relevant for inquiry-based learning. He kept the three points for inquiry-based learning as observation of the surroundings, a difference of empirical knowledge with existing knowledge, and judgment of the both knowledge. Hence, I got the STEAM philosophy, which largely believes in pragmatic, transformative, collaborative, and inquiry-based learning.

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Chapter V has been crafted to solidify my newly germinated idea in line with how I have been an empowering pedagogue. The major message of this chapter is that we have to think differently inside the classroom as mathematics educators or researchers. That means that the conventional method is not outdated. This is also the one learning process, even though it is insufficient. Hence, I realized from my long learning and teaching journey that the conventional (largely subject-centric pedagogy) teaching promotes learners' anxieties and deprives their hidden skills. In this regard, I have decided to conduct a research study on critically re/examining or reflecting on my conventional/progressive teaching pedagogies. Through the emerging STEAM approach, I am trying to transform from a traditional mathematics pedagogue to a progressive (empowering) mathematics pedagogue.

CHAPTER VI
REFLECTING ON MY RESEARCH JOURNEY

I want to remember my teaching journey, as I was selected as a pre-primary mathematics tutor in a private institutional school. When I entered a preprimary class (Grade -2) as a mathematics teacher in the middle of the session, I found that some topics were completed. I asked the children questions about the simple number system, but approximately ninety percent of the students could not answer. After that, I revised those topics for a week and entered new topics with some related concepts. After a week, I took a test on that topic, but about fifty percent of the students failed. On the result day of the class test, I badly punished those who failed. Still, I remembered that I always used to say to them I need marks whatever you do. I continuously taught them a similar method for a week and took a class test. Still, the position of the students is seen as the same. On the day of the result, I distributed their answer sheet, but I did not charge any punishment because that made me think and rethink my instructional activities. I counseled them about mathematics learning methods at the end of my class.

Then, that result made me feel about their result, and I asked my roommate, a mathematics teacher at a so-called renowned school. In the evening, we discussed that problem and concluded that those students need the very basic *concepts of mathematics*. He also told me that he had been facing the same problem in his classroom. But I could not get a satisfactory answer, and then the next day kindly, I asked the students why they could not do well in that mathematics examination. Or did you not know my teaching method? At the same time, one student told me, "*No, sir, you are right. We try to memorize mathematics but cannot remember, sir*." That touched my heart from their innocent voice. This symbolizes our teaching culture and tendency. That made me think about my research agenda.

In the previous chapters, the formulations of the research questions and the proposal and significance of the research encouraged me to join the different theories and genres. Applying autoethnography in my research helped me engage with the students, and the lived experiences of my teaching and learning of mathematics explored and tackled my research questions. The experiences of the teacher as a

conventional pedagogue turn into the empowering mathematics pedagogue, largely aligning with the STEAM approach, are the inspiring factors of my research.

Generally, mathematics is taken as a different and isolated subject; it cannot address real-life situations of the individual, but still, our learners are suffering from such deep-rooted anxiety. Among these various observations of mathematics, the maximum number of individuals share their disagreeable understandings and perceptions (Belbase, 2013). Most of us used to ask a question similar to the mathematics teacher's: "*Where do we use algebra in our daily life, sir*?" It seems to be simple but is an unanswerable question for us because our teaching-learning approaches are too conventional, meaning that we could not relate our subject matter with our daily context or real situations in the classroom through different pedagogical practices to the algebraic expression from the beginning of the classes. Those are the many factors that boost the student's anxiety in mathematics.

The demand for 21st-century skills may result in technical, economic, and social transformations and response to a quickly changing world and new encounters. Empowering our learners through the holistic meaning-making process collating Science, Technology, Engineering, Arts, and Mathematics (STEAM) would help promote engagement in learning, real-world problem solving, planetary conscious citizen, and many more contexts. As Lin et al. (2021) state, practical and hands-on learning are essential components of STEM, such as problem-solving and inquiry-based learning.

Furthermore, I learned mathematics through a rigorous process of rote recall and a largely iterative learning process. I read mathematics, but I was not aware of how mathematics germinated. This means that we do not know the philosophy of mathematics. So, what type of culture are we constructing? Such types of questions were raised in my mind.

It could be the day of January 2020 A.D.; we were at the top of the old academic building of the School of Education at KU. Our professors suggested we read the bundles of papers. One of the papers compelled me to shift my thinking paradigm. The paper was "Why is a STEAM curriculum perspective crucial to the 21st century (Taylor, 2016)?"

I had heard that our Nepali or local learning methods and methodologies were phased out or ruined and uninterested. So, we have to use global learning methods and methodology. After taking different concepts from the STEAM papers, I deny that

global context is superior or meaningful to local context. That's why I was compelled to think and rethink my conventional and empowering pedagogies.

This chapter reflects my research process as a research journey and its significance in the recent trend in mathematics education. At the beginning of my research, I discussed ideas, formulated research agendas, and articulated research questions, referring back to the theoretical references that have assisted me in finding out the appropriateness of the choices that I have made. I have used the approaches and the lenses in response to the research questions that help my research issue. Similarly, I have used my key learning and insights with implications and conclusions concerning my future directions.

Conceptualizing My Research Agendas

As a student, I had always assumed mathematics to be a sensitive subject. I started learning numbers and double-digit numbers in childhood in the form of "rote memorization," and mugging up the table of mathematics was another complex way of learning. The negative perception of my seniors regarding the subject was that rote recall is the best way of learning mathematics.

In my school days, most mathematical problems were based on foreign countries, so we didn't learn problem-solving using our daily activities. We also lacked a contextualized curriculum in mathematics to some extent. There were no alternative ways of mathematics teaching, and I used to face the same problems when teaching in different private schools. Students also used to take mathematics as one of the most complex subjects and were looking for some interesting ways to learn it. I always aimed to increase the students' motivation in the mathematics class. Counseling was not the only solution because most masses were against mathematics, so I thought of some tricks to promote the students' interest. I even wanted to teach them alternatively, which I tried many times, which would be more meaningful for them. It made me think and rethink the new dimension of pedagogical changes and the relevant syllabus.

Later, as a STEAM scholar, I joined Kathmandu University in the School of Education. I learned the different approaches and philosophies regarding teaching mathematics and the relevancy of the holistic approach in the education system. That made me to think and rethink it, and I kept practicing my profession under different conditions. On the one hand, I realized that such approaches would be the most useful and inspiring tools for mathematics learners who considered it a very complicated

subject in their learning process. On the other hand, as a STEAM pedagogue, that made me change my mindset differently and inspired me to be one of the best STEAM teachers. This method of teaching mathematics in the classroom was/is the most enjoyable, interesting, and meaningful one for the students. After selecting this approach in the classroom, students could easily and more confidently connect their mathematical problems more meaningfully to the day-to-day activities, the culture, and the socializing learning process.

I believe that teaching mathematics must change traditionally, and teachers should use the new approach in their teaching activities, which will be a better result as they can confidently connect it with their daily activities, leading to meaningful learning. The students seemed more motivated to read through different project-based learning, which helped them connect in the context of learning.

I was inspired to research the diverse modes of teaching and learning activities in different educational institutes. *My main agendas were the rote memorization versus art-based teaching method, theoretical versus activities-based learning, problem-solving versus conceptual learning, and marks obtaining versus meaning-making learning*. To promote motivational, interesting, and enjoyable learning and to develop my perception toward these agendas, I have taken it as an opportunity, as provided by my college and my facilitator, who has always been a supporting factor. Hence, the major concern of transformation or shift of learning is reflective practice learning. So, I learned that, for transformative learning, teachers/educators can introduce many kinds of learning inside their classroom, such as emphasizing to learners to learn new perspectives not as usual as we do in class. I/We have to help the learner to identify and question their assumptions, such as by giving opportunities for the learner to share their opinion and assimilate their ideas with the situation and time for reflection and analysis (Stetsenko, 2017). The most prominent point is the opportunity for critical discourse inside/ outside the classroom by giving space for conversation with small group discussion. Hence, the learner may shift the deep-rooted assumptions by involving in critical reflection and attempting their professional praxis (Rahmawati & Taylor, 2015). Hence, critical reflective practice is the gateway to transformative learning. Hence, my research is aligning from conventional to empowering pedagogues.

Encountering Key Concepts

Primarily, I have chosen two theories as referents. Those theories were Transformative Learning Theory (Mezirow, 1991) and Habermasian knowledge constitutive interests (1972). In this section, I discuss how I used theories in my study.

My study is guided by constructivist perspectives, which view learning as a process when the learner or student experiences an event in the lesson. That experience causes the students to think critically about how these new ideas fit with their current ideas or conceptions from activities. The teacher's role, in this case, is to engage students through interaction with the students and develop the different stories related to their day-to-day activities in a more meaningful way. As the teacher shares the different stories and facilitates classroom discussion, the students can develop new ideas and perceptions on the subject matter. They will start thinking of the connection of those stories with his or her work. If they continue this way, the connection and visualization of the new stories that the students get to know will make them grasp the concept and help motivate them. I agree with my research agendas with the version of Vygotksy (1978), who opines children can imitate various actions that go well beyond the limits of their capabilities. From different actions and projects, they come across the classroom that will give them a new vision of the problems, and they will start to think differently.

I also chose the Transformative Learning Theory, which was rooted in Jack Mezirow's work in adult education in 1990/91. I wanted to make sense of my narrative that showed the learners' perception and the students' activities. With the help of the different pedagogical uses and their activities, they can transform their ideas of mathematics into their new opinions. It is believed that the learners' experience and sharing their feelings through the stories was a more effective way of learning.

While presenting and "analyzing" my narratives, I attempted to recall the critical awareness of my past, present, and possible future, being aware of the world where I live. While doing so, I believe I was guided by the Transformative Learning Theory, as mentioned by Morrell and O'Connor (2002, as cited in Taylor, 2016). I presented those narratives that represented the activities, culture, sociological work, enjoyable moment, history, religious events, and their own experiences. In this context, transformative learning helped me greatly in my research. I wanted to focus on the fact that rote memorization is just conceptual, whereas the understanding that

comes through the narrative is more meaningful. It is the only possible medium for providing learning support to students. I want to analyze both my work and accomplishments just to make sure which was better, and it would be possible only through the judgment of the action from every activity I can do the self-reflection of my work.

Furthermore, I have gradually shifted from a positivist to a constructivist teacher. As proof, I have presented many STEAM projects on my teaching and learning periphery. I remember that, as Shrestha (2018), it still raises several questions, such as: Am I a constructivist teacher? Am I doing justice to my transformation in teaching and learning mathematics? And so on. These questions have made me take into consideration pedagogical practices. Further, I have been asking myself, Is there any shift in my consciousness? Arriving here, seeking the answer to my question, I will critically reflect on my pedagogical practices through epiphanies.

While searching for the theoretical foundation for my research study, I went through different educational research books, articles, and journals. As I intended to have a structural shift in my perceptions, feelings, and actions toward mathematics pedagogy, I found transformative learning theory very inspiring. Further, I have also realized that critical aspects embedded in transformative learning theory are very much needed for professional development and futuristic envision.

The transformative learning theory was proposed by Jack Mezirow in 1991. According to him, transformative learning is very useful in adult learning. They can/examine and critically reflect on their actions and thoughts. Through this, they/I can shift their belief system and improve their actions. Further, unlike everyday learning, transformative learning is about meaning-making to acquire knowledge. While making meaning of our experiences, there is a gradual shift in our perspectives. So, as (Perales & Aróstegui, 2024), “STEAM approach transforms education toward a more humanistic approach–without neglecting the scientific facet–that offers a well-rounded education to new generations as well as responds to the social and economic demands of our current world.”

Also, the ultimate goal of my research was to empower the learner through transformative pedagogy in the mathematics classroom. To achieve the goal, I also critically evaluate my deep-rooted beliefs. Teaching is for the emancipation of

students by addressing their common understandings and practices, enabling the learner and the educator to transform the learning environment (Pant, 2019).

Transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), and critical pedagogy (Freire, 1993) as the theoretical road map of my research inquiry theories helped me to solidify my ideas through the field text and my and my participant's (students) lived experiences. Hence, those are the boundary conditions to construct meaning and legitimate the meaning.

In conclusion, the wider cultural and social factors have played a crucial role in shaping my voyage as a mathematics pedagogue within the context of STEAM education. The cultural relevance of STEAM education, the effect of educational policies, and the role of cultural values and standards have collectively measured my teaching practices and contributed to the all-inclusive development of my students. As I navigate this energetic landscape, I remain committed to making optimum margins from these cultural and societal factors to create a meaningful and empowering educational experience for me and my students.

Developing Methodology

When I joined the MPhil in STEAM Education program at the Kathmandu University School of Education, I had many opportunities to learn methods, methodologies and ideas for teaching mathematics. In the same way, I got a chance to study the different paradigms. Similarly, in the course research methodology, I learned about the different research paradigms like positivism, post-positivism, interpretive, etc., suggested by (Taylor & Medina, 2019). While reading this paper, I learned that the non-positivist paradigm guided me. It was a more interesting part of another paradigm, like Interpretive. I found it with multiple realities, contextual knowledge, aiming at understanding other cultures, inter-subjective knowledge construction, etc., for the transformative notion of the research, making it more thoughtful to choose this paradigm in my research. In my experience of teaching and learning mathematics, I have had unforgettable moments that would last a lifetime.

I have presented different stories based on the connection of sociological evidence; those narratives supported the research work. So, to visualize and conceptualize the narrative scene, I choose the interpretive paradigm. The stories of the experiences of my classes were the agenda of my research. As an autoethnographic researcher in mathematics classes, I found this method most effective in connecting to the paradigm. I have selected interpretive and critical

paradigms for my research purpose to get the ground reality of the quest of my research question: how do teachers understand conventional and progressive methods of pedagogy in mathematics? I have to use an interpretive paradigm to get the solutions to my research questions. Primarily, ‘how’ refers to the methods of understanding/perception of the participants about the pedagogical practices with their narratives, experiences, and tales. So, it will help me to understand the culture or tradition using different pedagogical practices inside the mathematics classroom through interaction with the teachers and students. In this research, realities are, as Neuman (2016) asserts, social reality, which people perceive to be different from participant to participant regarding different pedagogical practices.

Similarly, the critical paradigm makes the researcher (me) develop critical self-awareness and understanding of complex social issues. Critical paradigm helps to empower the researcher/learner's awareness of different cultural contexts. My research will help me in the political dimension of the STEAM educational research part. It helps problematize unjust classroom practices and cultivate deep democracy and peace inside the classroom. Predominantly, why do (not) they practice these approaches, particularly in mathematics classrooms? And what are the different ways of conventional and progressive teaching approaches in mathematics classrooms? Those two questions helped me seek the paradigm of criticism because, by this paradigm, I use their experience and stories and try to critically assess the meaning process. Hence, I have selected the critical paradigm to empower the participants.

Hence, multi-paradigmatic research is a creative and systematic work undertaken to increase the knowledge of the specific problem. Educational research is a powerful method to transform society and the nation. So, I changed my idea to be a part of the research to transform society through different educational research such as STEAM research. STEAM research is education research that will help to transform our society through different dimensions of social construction, such as A (Art/critical), which will help society perceive humanity and make it aware of social values and beliefs as well.

In researching the STEAM approach in mathematics classes, I have used narrative/images and imagery methodologies because this methodology helped me to explore the mathematical concepts well and my narratives of the experience from my mathematics classroom. I have selected my narrative inquiry as it is the most appropriate methodology for my study because I was exploring the meanings of

experiences. At the same time, the process was a series of experiences and a journey (Trahar, 2011) that supported every piece of evidence from the mathematical questions.

Responding to My Research Questions

In my teaching activities in mathematics classes and my schooling period, I faced both supportive and unsupportive methods in my daily activities. From these activities, I have had a chance to develop the idea of teaching. So, I attempted to dig out the diverse ways of teaching mathematics from the beginning of my formal schooling to present the mathematics teaching and learning journey by portraying some critical episodes I experienced as a student, mathematics teacher, and mathematics teacher educator. While critically reflecting on my lived experiences, I perceived the different situations in the classroom, either as a student or a teacher. From these contradicting ways of teaching, I composed different research questions as follows:

1. How did I teach mathematics as a conventional pedagogue?
2. How have I been becoming an empowering mathematics pedagogue through STEAM education approaches?

I developed separate chapters for each research question to visualize beliefs from the experience of the teaching and learning activities in the classroom.

Addressing My First Research Question

I shared my childhood experiences in learning mathematics. Similarly, in the case of teaching periods, I have experienced mathematics as a rigid subject in my schooling and teaching career. Due to the language, algorithmic, and other teacher's teaching tendencies of mathematics, I did not have another option in the classroom.

So, I attempted to examine my beliefs and the experience of the past teaching activities to respond to my first research question. I discussed how I had presented myself as a content transmitter teacher in mathematics teaching. I discussed that I was a teacher for only giving the mathematical solution, and students should receive the idea and the solution from my lecture method. In the same way, I presented better grades as the main objective for the exam despite the conceptual learning. On the other hand, I have spent many years teaching in different schools and colleges to make my students secure better grades, thereby improving the school records. To fulfill my objectives and the school's administration, I needed to develop my skills to handle students inside the classroom. My identity was established as a teacher with

the *notion of an army commander* as a target receiver. I had spent eight years promoting the same situations in teaching and learning activities in the same institution.

To assure my readers, I have generated four themes as five narratives: Teacher as a drill-and-practice promoter, Practice makes a student perfect, Is this final exam question, sir! I need a good result in SLC (SEE)-Principal, Chant the important theorem, ditto no alternative idea: pass the final exam.

While attaining these themes for the first research question, I stood as a teacher, a content transmitter, or a conventional pedagogue. I have shared my experiences from my life's teaching and learning phases through my lived experiences. The representation of the conventional pedagogue in the teaching and learning field gave me a good experience. The main interesting part of this chapter is what I faced and what I was forced to do during that time.

Another part of my experience was focused on my conventional teaching and learning in different schools, which brought out my experience as a rigid teacher and learner that only taught the books, not the students. Those experiences of teaching and learning inside and outside of the classrooms presented as the transmitter teacher gave them only the theoretical knowledge in a controlled class environment. Finally, I realized that empowering mathematics pedagogues through STEAM education approaches is required to create a learning environment that empowers students to see themselves as capable and skilled mathematical thinkers within the broader context of STEAM education.

In this regard, based on my experiences, I realize that cognition tends to attain knowledge through deductive reasoning in a linear way as a product of didactic pedagogy, thereby subordinating/neglecting the key role of insight and sense in the meaning-making process while teaching and learning of mathematics (I. M. Shrestha, personal communication, November 27, 2016). So, the cognitive domain is insufficient for teaching and learning. There must be an effective domain as well.

Addressing my Second Research Question

To respond to the second research question, I attempted to examine my experience, perception, and beliefs regarding mathematics in different places. I discussed how I had presented the causes of the contributing factors of the practices. I was not happy with the teaching method, which promoted only lectures and only problem-solving concerning mathematical solutions or conventional pedagogies.

The non-democratic classroom and autocratic teacher can't motivate the students, and they can't conceptualize the mathematical idea meaningfully. This research question entails my experiences with the inspiring factors from my STEAM educational journey despite my absolutist teaching and learning journey by addressing the second research question. What causes contributed to my turn from a conventional pedagogue to an empowering mathematics pedagogue through STEAM pedagogue?

Furthermore, during my professional development at Kathmandu University, I joined an MPhil in STEAM education program. Almost two months later, we changed from face-to-face mode to online mode classes due to the Covid-19 pandemic. Initially, I struggled to cope with the online method of STEAM classes due to the lack of proper connectivity facilities, knowledge, skills, and basic inspiration for actively engaging in teaching, learning, and assessment. The facilitators provided rich motivation by acting as the best scaffolder. Slowly, I began to cope with online classes, managing my time and finalizing the preferred activities and assignments on time by actively participating in the transformative knowing, doing, and being like designing and implementing STEAM-based projects such as design thinking projects, artist-teacher collaboration project, TED-TALK and so on. Through these transformative activities, I also envisioned the STEAM-based mathematics lesson plans that broadly focused on self-consciousness to develop holistic thinkers. My research inquiry's emancipatory interest-based theoretical stance also focused on self-reflection for emancipation that promotes autonomous, responsible action (Grundy, 1987). The online mode of MPhil STEAM classes greatly supported me in conducting my regular online mode mathematics classes, and those types of incidents helped me to tackle my second research question to knit empowering pedagogy in mathematics teaching.

Here, I have presented five narratives to solidify my second research question. My experiences as a *Personal/Educational Narrative, Professional Narrative, and Cultural/ Collaborative Narrative* regarding an empowering mathematics pedagogue through the STEAM approaches. While addressing those themes of the second research question, project work on mathematics is too essential and an effective teaching and learning strategy. I want to remember that incident that made my participants spellbound towards the subject matter, which I have included in chapter five. So, I came to realize that project-based learning is a student-centric teaching approach, which helps the learners to be creative, imaginative, and real problem

solvers as well. My belief systems also challenged and envisioned the STEAM approach to displace the "chalk and talk" pedagogy and embrace new scientific methods as student-centric, collaborative, and inquiry-based learning pedagogies. My learning journey as a STEAM scholar has helped me learn about the importance of this multidisciplinary approach in pedagogical practices. So, a unified curriculum (STEAM) aims to assist students in changing their learning performance and engagement and prepare graduates for real-world problem-solving challenges (Guy, 2013).

My Key Learning

As an autoethnographic researcher, I must share my current condition as an empowering mathematics pedagogue. Reflecting on my past experiences, I recognize that the rhetorical style of my learning and lack of connection with real-life situations in mathematics learning were the major problems in mathematics classrooms. During the study, I engaged myself as an inactive learner. So, I started a new concept of teaching activities as a STEAM pedagogue in the mathematics classroom. Along with my research task, I escaped the traditional method of teaching mathematics. The new teaching ideas were more effective and meaningful in my teaching classes. I learned that it helps to encourage personal feelings of positivity in mathematics and compels me to think to the learner it is a favorite subject rather than an absolutist view of nature. Now, I could teach the students by enjoying what they do and making them happy.

Rather, from the transformative journey of STEAM education, I learned that we need to change our teaching and learning tendency as per the context and self for improving and shifting towards transformative learning and developing self as an agentic being. In doing so, I realized to incorporate the notion of Stetsenko (2017). This transformative activist stance emphasized unified transformative ontology for shifting my positivistic ontology-guided professional math practice towards the transformative knowing, being, and doing beliefs. Moreover, I also realized that research-based teaching and learning are necessary for our professional development.

Further, I realized that the cause of the difficulty in mathematics is a lack of prior mathematical knowledge. As in Chapter IV, I used to consider the condition that the students have basic mathematical skills while teaching mathematics by applying STEAM projects in the classroom. The STEAM approach is a multidisciplinary learning approach that supports the emergence of new knowledge and learning with

the attachment of different disciplines inside the same world and a hands-on innovation process. For the innovation process, in this research, Critical constructivist thought is too important because it helped in many critical aspects of my research. For example, in different classroom cultures/settings, the hierarchy of thought with many hidden obstacles encourages the questioning of dominant systems of knowledge production and the opening up of dialogue concerned with critical awareness. This awareness offers different kinds of inquiry-based learning with collaborative models by constructing tangible prototypes of ideas and concepts reflecting through design thinking (Culén & Gasparini, 2019). Also, criticalism emphasizes (Habermasian theory perspectives) the researcher's positionality concerning critical theory perspective, critical consciousness and reflexivity, questioning assumptions, and developing the logic of empowerment. Hence, constructivism (critical/social) was very important in pragmatically achieving my research goal.

Implications

The implication of my research is in the educational field. It helps to promote and motivate different sectors for their personal development in a meaningful way. This study assists the teachers, experts, curriculum planners, and policymakers in understanding the existing situation and practices of social justice in mathematics classrooms. It gives insights for transforming teaching methods, reforming curriculum, and promoting democratic justice in the classroom. Instead, this research will help those eager to know about the implementation of STEAM education in the mathematics classroom. The above literature suggests that STEAM education has profound implications for teaching mathematics. It moves mathematics from an abstract discipline to contextualized, creative, collaborative, and culturally relevant (Ng, Kewalramani & Kidman, 2022). This shift helps students develop mathematical skills and a broad set of abilities necessary for success in a rapidly evolving, interdisciplinary world.

Furthermore, this research is expected to provide vision and encouragement to teachers and students to facilitate different curricular activities to frame mathematics in different dimensions. It will also support the change in mathematical beliefs, assumptions, and perceptions as necessary in mathematics. This research will help shift the pedagogical system and will make me aware of the use of pedagogical methods in the mathematics classroom. In the current context of Nepal's fragmented (compartmentalized) subject learning system with compartmentalized pedagogies, this

research will help the math/science teachers generate innovative and holistic meaning-making pedagogies as well. The major significance of this research is to improve the mathematics classroom through the emerging pedagogies in a synergetic way or by emphasizing the holistic meaning-making process (STEAM).

For Myself

From the experience and the research of my agendas, I explored and visualized the different methods and methodologies as a mathematics teacher and educator for motivation and meaningful learning. Being a teacher, I had the chance to implement in every class of mathematics to STEAM approach. To make contextualized and socially connected mathematics, I got to implement it in every engineering mathematics class. My study can enable teachers and students to generate relevant knowledge transferable to other classroom situations. It will be helpful for me to generate and co-construct the mathematical designs in a conceptualized way. Every research study has its purpose and some implications for others and the researcher himself/herself. My research study certainly has implications for myself, the mathematics education community, curriculum committees, teachers, teacher educators, students, and schools in constructing a vision of developing my pedagogical sensitization towards holistic mathematics education through transformative education (Shrestha, 2018, p. 258).

For Policy Makers

I hope that policy makers can compose the policy according to their routine with the help of my research and would certainly make those teachers who followed the teacher-centered method, only theoretical knowledge, the rote memorization, and who believed the scoring more marks despite conceptualizing are more beneficial, change their mind, and hopefully adopt the new version of teaching-learning methods. In the context of multidisciplinary (connected learning), the STEAM approach helps to construct a vision of developing pedagogical sensitization towards holistic mathematics education through a transformative STEAM educational approach.

Future Directions

After completing my M Phil dissertation, I will always be keen to share my research process and insights with my colleagues, research participants, seniors, policymakers, and research scholars. This process would help to enrich knowledge on dis/empowering in the mathematics classroom. I reflected on my narratives and

experiences of the common teaching strategies of mathematics teachers in the mathematics classroom.

I want to apply teaching and learning mathematics in the classroom to explore the cognitive level of the students in the mathematics classroom while connecting with innovative pedagogies. We need to teach mathematics to strengthen students. Understanding through the STEAM approach for the holistic development of the learners connecting their real-life situations.

It helps to promote students' thinking and strengthen their understanding and the meaning-making of mathematics at every step of their lives. This study will be an academic reference for further studies. Finally, future researchers may delve even deeper into other dimensions of understanding.

Conclusions

As a human being and a professional math teacher, teacher educator, and researcher, I believe there are indefinite experiential moments in our lives. Those important incidents helped me to explore my past to knit my present and shape the future as an autoethnographic researcher. To accomplish that autoethnographic research, I used different big theories, such as transformative learning theory and knowledge constitutive interest, with different paradigms in the meaning-making process.

So far, research is an ongoing process. The conclusion of my research is not the ultimate truth. All knowledge is subjective. It depends upon the views or perceptions of each person. I developed the idea that the teaching and learning process is true in that time and context of experience, stories, dialogue, and teaching activities would be eye-openers in instructing me on my beliefs about mathematics. I found that mathematics is complicated due to the lack of a connection to the daily activities of mathematics. Students would be empowered by sharing their feelings and connecting their work with mathematics. The culture and daily activities represent stories that motivate the students through the social constructivism approach. From the class discussion to their own stories, they also promote their ideas meaningfully. I found that within the context, I seem to understand only the relationship between the use of the STEAM approach as a pedagogical tool in teaching-learning practices and its effects on students' success, inspiration, interests, and assessment of learning activities (Qutoshi, 2015).

A major part of my research target was aligned with the question, why do learners dislike learning mathematics? Is the teacher-centered method always the best method for mathematics classrooms? Why is mathematics always a burden to students in school, college, and university? How can it be a favorite subject for students? Such pertinent issues always touch my heart and mind when I think about this research agenda. So, my research agenda germinated in different situations, such as a one-size-fits-all approach in the mathematics classroom (Luitel, 2009). Kafle's (2022) report on the Curriculum Development Centre (CDC) of Nepal shows that child-centered pedagogy is still hindered in Nepal.

Hence, changing from a conventional pedagogue to an empowering mathematics pedagogue, transformative learning theory guided me to develop the experience and classroom practices with students. My autoethnographic research helped me to express my feelings and experiences through the narratives of the journey from conventional to active/artistic/progressive pedagogue. The perception of mathematics as a foreign and useless subject can be visualized to some extent in the daily activities-based subject through the connection with the STEAM project, as I have done in chapter V.

I concluded that this teaching approach promotes the students to be more creative and constructive. Students can connect the example of their daily activities to the mathematical work. So it makes the learning process more meaningful. In the same way, I connected this theory with my narratives and projects. It promotes classroom teaching to be as enjoyable and motivational. The monotonous teaching in the classroom and the rigid ways of teaching hampers the creative ways of the learning process. My research aimed to empower the learner through transformative pedagogy in the mathematics classroom. To achieve the goal, I also critically evaluated my deep-rooted beliefs. Teaching is for the emancipation of students by addressing their common understandings and practices, enabling the learner and the educator to transform the learning environment (Pant, 2019). At last, transformative learning theory (Mezirow, 1991), knowledge constitute interests Habermas, 1972), and critical pedagogy (Freire, 1993) made a theoretical road map of my research inquiry theories helped me to solidify my ideas through the field text and my and my participant's (students) lived experiences. Hence, those are the boundary conditions to construct meaning and legitimate the meaning of research.

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