INTEGRATING STEAM PEDAGOGY IN SECONDARY MATHEMATICS: A PARTICIPATORY AUTOETHNOGRAPHIC INQUIRY

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A Dissertation

Submitted to
School of Education

in Partial Fulfilment of the Requirements for the Degree of
Master of Philosophy in STEAM Education

Kathmandu University
Dhulikhel, Nepal

March 2023

AN ABSTRACT

of the dissertation of *Sandip Dhungana* for the degree of *Master of Philosophy in STEAM Education* presented on 23 March 2023, entitled *Integrating STEAM Pedagogy in Secondary Mathematics: A Participatory Autoethnographic Inquiry*

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The STEAM, composed of the aesthetic components of our society and STEM disciplines, has been considered one of the transformative learning approaches. It is observed to be significant in promoting progressive pedagogical activities. The decontextualized nature of mathematics, pedagogical practice, and professional development of teachers was considered the major problems in this study. In finding the solutions to those problems, this study aims for two significant purposes. The first is to critically reflect on my pedagogical practices as a STEAM teacher and an educator. The second is to explore how STEAM pedagogy helps me (as a practitioner-researcher, teacher, and teacher educator) and my co-researchers (participant teachers) at the secondary level to improve our pedagogical and professional practices.

This study represented my lived experiences as a learner, teacher, educator, and practitioner. I incorporated a participatory autoethnographic design blending Autoethnography and Participatory Action Research (PAR). Knowledge constitutive interest and transformative learning theory guided me both as an autoethnographic inquirer and a PAR researcher. The participants of this study were five teachers at a private school in Kathmandu Valley. This study was based on the narrative stories that I collected from my own experiences as an autoethnographic researcher and the experiences of co-researchers, along with my self-inquiry from the PAR context. The data and information were collected from the field by the three Es (experiencing, enquiring, and examining) models of Mills (2011). The collected narratives were discussed under three major headings: the transformative shift from conventionality to

STEAM activism, the journey from mirage to the reality of STEAM pedagogy, and enhancing harmony and transformation with sustainability. The collaborative work in PAR made us aware and critical of what we were practicing in our earlier days. It promoted us to explore a better learning environment for our learners. We critically reflected on those conventional assumptions and practices in which we were following our professional skills. We realized that teachers and students are equally responsible for creating a learning environment inside and outside the classroom. The co-construction of knowledge and mutual understanding in designing the STEAM projects gave us new pedagogical scenarios. This intervention helped us to challenge our one-size-fits-all pedagogy and silent classroom practices.

The mathematics-driven intervention helped each of us to find the connection between our disciplinary learning with real-world practices. The notion of a disorienting dilemma and collaborative approach enabled us to clarify each illusion and question. In addition, we (the PAR team) found the importance of affective domains in mathematics classrooms. This intervention made us realize that mathematics is an emotional subject. The fear and boredom of students towards the teacher and subject can be converted into relief and interest.

As an insider in this study, I found my role as a meaning-maker and meaning-seeker rather analytical. The importance of continuous learning and engagement in self-exploration for both teachers and students was also a major finding of this study. We (the PAR team) realized that transformation is a continuously changing process of one's assumptions and practices. We (the PAR team) found that the STEAM practice can shift the educational paradigm from a teacher-centered to a learner-centered approach; from a knowledge-centered to a skill-centered approach; from a theory-centered to a real-life-centered approach; from a positivist to an art-based approach. It is an approach that brings multi-disciplines together to take a holistic picture of education that is beyond the disciplinary aspects.

Being a teacher, educator, and researcher, I realized the lack of TPD of progressive pedagogies in our teachers. The notion of the STEAM approach could be a way to establish progressive thoughts and innovative ideas in our teachers. Such contribution can enrich the transformative thoughts and practices in our educational system. The motivation and positive attitudes of the participant teachers towards the STEAM approach after the intervention show its sustainability in their professional skills. Teachers were actively engaged in drawing their classroom environment full of

artistic pedagogical practices. Role play, drama, songs, and dance were the major ones. The impact of arts on learners' affective domains has been observed, revealing the intrinsic importance of emotions and motivations in mathematics learning. Through self-reflection, we have become aware of the concepts of learn, unlearn, and re-learn. Implementing new ideas in any context can be challenging, but empowering participants and recognizing their ideas, thoughts, and practices can lead to better approaches.

As the government of Nepal has already executed an integrated approach at the early basic level, this study can be utilized to understand the pros and cons of the integrated STEAM approach at the secondary level (Grade X). Such study in the Nepali context can build pillars for innovative pedagogical practices and might make people believe in those practices. Likewise, a secondary teacher can take this study as a reference and be aware of his/her pedagogical practices. The real-world settings and the teachers' reflections on their practices in implementing STEAM plans can make the readers empathize with their scenes.

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DECLARATION

I hereby declare that this dissertation has not been submitted for candidature for any other degree.

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DEDICATION

I dedicate this dissertation to my parents Mr. Madhav Prasad Dhungana and Mrs. Sabitra Dhungana. To my siblings Sudip and Shreya.

To all the loving hands who supported me directly and indirectly in every step of my life.

To all the readers!

ACKNOWLEDGEMENT

Thank you to my parents and family members who continuously supported my academic achievements and provided enough time and support for it.

Thank you to all the participants of this study, without their contributions, I would not come to this stage.

I would like to thank the University Grant Commission (UGC) Nepal, for supporting me financially as a young candidate through the MPhil Research Fellowship program to accomplish this study.

Firstly, I am very grateful to Prof. Bal Chandra Luitel and Asst. Prof. Binod Prasad Pant; they have been constantly unstinting their support as the dissertation supervisor in this study. Their critical concerns about my interpretation have always made me reflect, re-think and re-visit every single piece of text time and again, which ultimately helped me to position myself in my textual analogy. Their continuous support from the beginning of the study to the end is commendable.

My gratitude also goes to the faculties of Kathmandu University School of Education (KUSOED), especially Dr. Parbati Dhungana, Dr. Shree Krishna Wagle, Netra Kumar Manandhar, Ramesh Thapa, and a PhD candidate Mr. Niroj Dahal who were always there to resolve my academic difficulties from the beginning to the accomplishment of this study.

Thank you, Sarita, who helped me, in transcribing the audio/video files and supported me in the workshops and informal sessions in the research school. In addition, I would like to thank her for her valuable input and critical suggestions in this research journey.

Thank you all who were always there for me!

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ABBREVIATIONS AND ACRONYMS

ABL	Arts-Based Learning
B. Sc.	Bachelor of Science
BA LLB	Bachelor of Arts - Bachelor of Legislative Law
CDC	Curriculum Development Centre
CTS	Creative Thinking Skills
ERO	Examination Review Office
IBL	Inquiry-Based Learning
K-12	Kinder Garden to Grade 12
KU	Kathmandu University
MBS	Master of Business Studies
M.Ed.	Master's in Education
M.Phil.	Masters of Philosophy
NEB	National Examination Board
PAR	Participatory Action Research
PBL	Project-Based Learning
SEE	Secondary Education Examination
SLC	School Leaving Certificate
STEAM	Science, Technology, Engineering, Arts, and Mathematics
STEM	Science, Technology, Engineering, and Mathematics
TPD	Teachers' Professional Development
TU	Tribhuvan University
TV	Television

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BEFORE I BEGAN

The piece of my academic work as a researcher was born from the connecting dots from my master's journey to my MPhil. In my master's dissertation, I explored problems in learning geometric theorems in secondary schools as a mixed method study. I was guided by a survey followed by narratives in this study. However, when I attended my M. Phil. classes, I was more critical towards myself, which I had expressed in the assignments given to us, and those critical reflections became the turning point for this study. Though I was always interested in exploring new approaches and innovative pedagogies in mathematics education, I was less aware of the integrated, multi and trans-disciplinary teaching and learning approach. The course facilitations and assignments during my first/second semester provided ample opportunities to reflect and critique my practice, and working with multi-diversified classmates sharing ideas from different subjects added and broadened my horizon. How can the STEAM approach be applied to higher grades? Will I be able to connect mathematics with other disciplines? Being a mathematics teacher for a decade had blocked my vision to look forward, and I tended to confine my knowledge within myself. I explored multiple innovative ideas through STEAM lenses during class activities and presentations. Yes, that is how I gained confidence and step ahead to design STEAM projects inside my classroom. I enjoyed it, and students from my classroom also had unique experiences in their learning journey. I solely conducted the project in the beginning, and after gaining ideas to collaborate with other subject teachers, methods, and approaches, I decided to do this research. If there had been less critical academic reflective writing in my first and second semesters, I wouldn't have started exploring my dissertation journey. This journey started with my perception, thinking, reflecting action again, reflection, and empowerment.

The readers may find this autoethnographic inquiry as a way-out for the exploration of my past experiences along with the current collaborative practices. Besides the texts, you will find different figures in each chapter of this study. You will find two types of figures in this study: context-based figures, which are discussed in the nearby paragraphs with their context, and metaphor-based, where the pictures only speak, and I might not have discussed anything about them in the text. Those

metaphor-based figures are kept highlighting the meaning of nearby text/paragraph through art.

CHAPTER I
DELVING INTO THE RESEARCH STUDY

It was a day in 2021; I was in the first semester of my MPhil study. Asst. Prof. Pant was our facilitator in the research methodology course. I was aware of the architecture of the research building as I had already worked under his guidance in my master's study. Though his inputs and insights helped me extend the boundary of my learning, I found myself more familiar with transformative research methodologies like autoethnography, action research, and other qualitative research approaches. In that semester, we were supposed to prepare a proposal as an assignment for the requirement of this course; for this, I had gone through different literature and found most of the research related to STEAM education and STEAM pedagogies were beyond my context and cultural practices.

All the sessions at the university were going smoothly. Each of the facilitators discussed and facilitated innovative pedagogical practices and STEAM education. I started to reflect upon my practices. Then I realized the gap between what I was studying at the university and what I was practising in my professional context.

I continued reflecting critically, either in my assignments or within the self. I even took a few journeys of the earlier dissertations from my university library. Many scholars were found critically reflecting on their academic journeys as autoethnographic inquirers. At this moment, I also realized that I could prepare a similar project. The fact is: I believe that each individual has a unique experience.

I started my journey as a critical self-reflector, but again I stopped. I stopped because of my 'ego', the ego of a mathematics learner and a facilitator. The character inside me started to question:

Why am I trying to adopt a qualitative research methodology?
I am a mathematics learner; I could do a survey or something different where I can perform some mathematical computations.

I was in a dilemma. I tried here and there, this and that, quantitative or qualitative or both as a mixed or something that represented and expressed my purpose and the dilemma. In this debate of thesis and anti-thesis, finally, I synthesized as a critical self-reflector, an autoethnographic inquirer. But in this autoethnographic journey, I realized that what if I take an action on what I have learned. At this moment

I was remembering Asst. Prof. Pant, with his slides on 'knowledge, skills, and attitudes' in any session and realized that whatever I had experienced in my past journeys, now I am gaining transformative pedagogical knowledge and skills which can be implemented in any real-world context.

Yes, this is the time to show attitude. I mean to bring knowledge and skills to action. This thought gave arise to a new methodological stance in this study and i.e., PAR (Participatory Action Research) inside autoethnography. I delved myself along with my co-researchers as part of this study to transform our pedagogical thoughts, beliefs, and practices.

Yes, now I got the big-picture of my research.

The Unseen Picture in my Educational Journey

I am from the Eastern part of Nepal where I pursued my school level education. From my early years, mathematics was my favorite subject. Embarking on my mathematical journey as a student, if I need to review my encounters in learning mathematics, I need to begin sharing from my school level where I was fond of mathematics and enjoyed doing calculations, solving problems, and proving theorems however in a few sections I was having difficulties such as in geometry, arithmetic, and algebras. I used to get good marks in mathematics and get appreciated by my teachers and parents as I was a so-called bright student in their perspectives. As far I could recall my past, I was a good performer in mathematics at the school level as an algorithmic problem solver up to the lower secondary level (up to Grade VIII in Nepal in those days). From this level, I discovered a few troubles in understanding mathematical hypotheses and their applications to tackle other mathematical issues. The majority of the mathematics concepts in the Nepali curriculum are contained in the abstract form simply named 'definitions' and 'formulas' nonetheless I can find this approach in other subjects too. At the point when I am concentrating my writing at this level, I found my mathematics teacher was possibly guided by lecture-based practices and less aware of the real-life applications of what we had learned. He might be less familiar with the artistic and innovative pedagogical practices like PBL (Project Based Learning), IBL (Inquiry-Based Learning), group/pair learning, and so on while teaching mathematics, rather he used proof and argumentation in a straightforward method on the mathematical statements appropriately. He simply used to show us the fundamental ideas and used to overlook the majority of its segments in the areas like geometry and algebra. I have just learned the circumscribed ideas in this

section from my teachers which was only focused on the examination procedures and we (my classmates including me) used to memorize them as said by our teacher just to barf in the examination hall without any understanding.

I started to work as a mathematics teacher in 2011 A.D. in one of the secondary schools in Jhapa (a district in eastern terai of Nepal). I too followed the same strategies, how I was taught, with my students in the beginning days as a mathematics teacher for the same level. I was also unknown of the novel approaches and strategies which can be integrated with teaching and learning mathematics. I realized that mathematics was being taught in isolation which failed to address the need and interest of the learners in learning mathematics and to address this issue integrated approach was needed. Though I was laboring my best to get the desired output from the students; the achievement of my students in mathematics was just the opposite. I might not have tried or was not aware to face the new challenges from the front line in teaching mathematics and always reproduced what I was taught and how I was taught. Yes, very few students in my classes indeed used to achieve excellent marks/grades in mathematics at board exams but the majority of them were at the average level or below it. I found that students can build up their skills to yield conceptual understanding and its implication in their real life if a teacher or a facilitator comes out of the status quo in teaching –learning any mathematical issues or statements. As I was unknown with the integrated practices in mathematics, I used to think that a teacher is all in all to teach any subject and one size fits all strategy is only the strategy to teach inside the classroom. My beliefs and cultural practices in teaching and learning mathematics got reformed after joining Kathmandu University in 2018 for my master's study.

The above scenario might be common in our Nepali school and my experience might represent the experience of an ordinary student or a teacher at any secondary school in our country (Shrestha, 2018; Dhungana, 2021; Manandhar, 2022). In my experience, the teaching and learning practices in mathematics are highly devoted towards the grades and scores in the examination papers, because of which our system might promote rote learning in mathematics which declined the reasoning ability of any students and failed to produce the conceptual understanding for any mathematical ideas or statements. Compartmental study among the subjects and within the subjects with the topics and area of study also encourages them to understand each idea and concept of mathematics independently. The students are not only failing to connect

the mathematical logic and concepts to their real-life but not able to connect to the next area or concepts within mathematics and other subjects. Our classrooms and teaching-learning styles are less focused on collaboration and communication as the majority of us (as a teacher) prefer our students as passive listeners and individual problem solvers in our classes. I experienced that mathematics teachers are highly focused on marks and Grades on the examination rather than the critical thinking and creativity of the students in mathematics. Students learn the idea and concepts of mathematics just to see higher grades and marks on their report cards and our society praises more for such written documents rather than the student's concepts and skills.

This integration helps improve important 21st-century skills such as creativity, critical thinking, collaboration, and communication (Daugherty, 2013; Quigley, Herro, & Jamil, 2017) by providing a more well-rounded and engaging educational experience. The STEAM approach has emerged as a result of incorporating arts into STEM education to improve student learning, foster creativity, and increase their potential for success in the 21st century (Liao, 2016). This approach teaches students to think holistically across multiple disciplines (Sheffield, et al., 2018; Yakman & Lee, 2012), promoting a more comprehensive understanding of the subjects and their real-world applications. The integration of multiple perspectives of STEAM education in mathematics learning like S-science can connect learners to nature or the real world, whereas T-technology can connect them to modern or innovative ideas; E-engineering enhance students' creativity in designing and developing the concrete objects (concrete objects here means any type of useable tools like software, robotics, local material, etc.). Likewise, A-arts can immerse the learners in his/ her cultural setting and make the learner feel proud of their own cultural phenomena. M-mathematics refers to the mathematical computations in the real-world context. Such pedagogical practices enable the learner to understand the holistic picture of any real-world phenomenon. In this way, STEAM learners not only learn mathematics through this approach but may found own self in such a learning environment where they can learn how to live and might be able to understand to solve the problems of their context.

The connection of different perspectives in mathematics or might be looking at mathematics from different lenses like science, technology, engineering, and arts make learning more insightful for any learner (Manandhar, 2022). 'S' in the STEAM approach helps to connect a learner with nature which shows the primary existence of

mathematical ideas in the learners' context. If we are connecting 'bara' (a typical Newari food) as a theme in the STEAM approach, then we could connect it from the production of the floor and the sources of ingredients up to its making. Its circular shape can be connected with concepts of circumference, radius, diameter, area of a circle, and so on. Likewise, we could connect the science behind its production and its impact on our health. Similarly, its essence in Newari culture connects the cultural phenomena in the classroom. Such a holistic approach might connect the learners to their real-world practices and make learning meaningful. Likewise, the use of Doko, Nanglo, Namlo, Mandro, Gundri, etc. (some typical Nepali artifacts used in daily life) in some context; patterns in temples, stupas, and landmarks also represents different types of geometrical patterns which are not only the symbols of our cultural perspective but easily connect with our curriculum; the interconnection between other subjects in STEAM helps to inquire and to have integrated depth knowledge rather than compartmental knowledge (Maeda, 2013). The manufacturing of those artifacts and their uses in our society represents the technological and engineering aspects of the STEAM approach. "The "T and E" of STEM Education appears to be a stumbling block to producing a meaningful STEM experience for K-12 education students" (White, 2014, p.5), and the integration of arts in it connects the learners' feelings and emotions in the learning area. In my opinion, the aesthetic components of our society are the major source of learning for any individual which not only built the steps on someone's education but provides a strong base for their learning. Being a STEAM practitioner in K-12 education, I prefer a creative design and affective touch with the integration of one's culture, arts, and technology in learning mathematics and science. Several studies (Noh & Paik, 2014; Lim, Kim, & Lee, 2014; Lim & Oh, 2015) have advocated the teachers' perception and practices in STEAM education and found a positive impact on students' motivation and learning. In this scenario, I as a researcher have revealed my pedagogical experiences, beliefs, and practices being a critical reflector. Likewise, I have displayed the picture of STEAM intervention in one of the private schools in Kathmandu through PAR (Participatory Action Research) study.

Question mark (?)

A boy growing up in a village
Who'd expect he could go up so high
Studying in a lantern light
Mind was filled with questions at night

Question mark, he was afraid to ask
He was told not to show curiosity
He kept in a mind
listening, memorizing, copying faithfully

He was expected to be well behaved
Yes, the burden of house chores was on a side
Will he dare to break this norm?
He decided to escape for being a kite

A teenager admitted to a city college
Things were changed there
Obviously, he attempted to express his curiosity
Shut up! He got the answer not to care

Teacher said,
Just read what was given
No boundaries to be crossed
Suppress your question mark
Sushhhh, No more questions on my period

The student was afraid
Ok, accepting what to be asked
Pin drop silence, No more talking with peers
Just focused on a task

One day he got a job
Teaching was going with a high low pitch
Where were his sword and shield?
He forgot on a field

He was a hero
Bang... the sound came from his class
Wow, with a stick and a question bank

His students' marks were his pride
Bang-bang, some tears came who obtained zero

Years passed,
He became a well-experienced teacher now
Rudeness and strictness were his asset
Hold on! What just he heard?

Constructivism, Peer learning, PBL
Damm, the curious mind again activated
Wait a minute....
Something was happening which were crucial

What? He realized,
Actual learning is not just chalk and talk
Deep in his heart and mind
As a child,
he remembered how his curiosity was bind

Oh, No,
This was not the way
He mourns and regretted inside
All these years,
He was behaviorist as he says

Learning, unlearning and Relearning
The transforming process has started for
Oh boy, what was going on
His teaching was not the same as before

His forgotten smile came to life
Inside his classroom noises were heard
ABL, IBL, PBL

Yes, this is what his students are dived

Wow, this feeling
He is not teaching the brain only
touching students' heart
was something he learnt

Throughout his journey
new things have appeared
Yes, things are modified and changed
Still, a question mark to move forward

It was any day in 2008, I remember our science teacher teaching Newton's law. He started by sharing how Mr. Newton discovered the earth's gravity, the power of curiosity arouses from the general phenomenon of a falling apple. On the contrary, he rarely appreciated our inquiries in science classes. The above poem is a product of curiosity. The power of question marks produces much knowledge. On the other hand, in the transformative learning process, the inquiry revolves in a circular form which indicates that the inquiry and learning never ends. The poem illustrates the level of curiosity which was killed in the teacher-centric classroom and revived during my university days.

What Makes Me Realize to Contribute to this Research?

In this study, I have reviewed the articles, dissertations, and other research studies related to STEAM education and STEAM pedagogy. The reviewed studies helped me to formulate research questions and research gaps. I as a researcher felt the need for this study based on the reviewed research and designed the purpose of the study on STEAM pedagogy in my context. This review is a critical review in which the literature critically provides the foundation on which the research is built. A study like Perignat (2019) conducted a convergent mixed method design in a STEAM-based classroom that examines the relationship between the creative ideologies and creativity-fostering behaviors of six teachers in a 5th grade, STEAM class. In this study, teachers' classroom behavior was included through survey responses whereas semi-structured interviews and field notes were collected to address the qualitative sections. This study provides insights into teachers' perceptions and capacity to foster

creativity in a standalone STEAM class. Although this study is aligned with STEAM education in examining teachers' creativity, my interest is different in terms of the grade of the students and the integration of STEAM in mathematics.

Likewise, Scruggs (2019) has conducted a study on "How Content Teachers Transition to Teaching a STEAM Curriculum" which is a multiple case study. The purpose of this study was to inquire about the transition of teachers of previous educational practice to the STEAM approach and concluded with four themes; where teachers developed a mindset to teach from a STEAM perspective, started small and built up, use collaboration as a resource, and participated in ongoing professional development. This study also found that the transition of the teachers appears to support Mezirow's (1991) steps of transformational learning theory. Though my research design is aligned with STEAM, it is different in the sense of methodology and research purpose than this study.

Jammie (2019) researched the use of STEAM-based activities in a Hong Kong school to assess students' creative thinking skills. The study utilized the Makey-Makey invention kit to design human-cantered instruments, addressing everyday problems through a combination of knowledge exchange and personal experiences between the student designers and users of various ages. The methodology adopted was a mixed-method design, including class observations, interviews, and questionnaires to gather perceptions from both teachers and students who participated in the STEAM project. This study highlights the integration of STEAM pedagogy in solving real-world problems through student-designed projects. In comparison, my study focuses on incorporating STEAM pedagogy in secondary mathematics teaching.

Likewise, Manandhar (2021) contributed to a Transformative STEAM Education through his autoethnographic journey. In this thought-provoking autoethnographic research, the research aims to bridge the gap between his academic and non-academic experiences, to envision a transformative STEAM education that is empowering and inclusive for all. Further, he aims to improve his pedagogical practice as a STEAM educator by critically examining his own experiences and practices. As STEAM education is in the infant stage in our country this study/dissertation is a benchmark or first dissertation research in STEAM education as per the record of our university. This study is purely an auto-ethnographic inquiry where as auto-ethnography will serve as the first phase of my study. My study is

different from this study from the mythological stance as I have incorporated multi-methods (auto-ethnography and PAR).

Similarly, another autoethnographic research: Rijal (2022) is done to critically reflect on the researcher's journey of teaching and learning mathematics in a separate subject-centric environment. This study has also envisioned the researcher's future pedagogical practices incorporating a multidisciplinary STEAM approach. This study adopted autoethnography as a methodological stance. In this study, the researcher has unfolded his pedagogical voyage through which he was guided as a learner and a teacher and then he proposed his vision for academic practices through inter/multidisciplinary STEAM approach. He presented his role as a change-maker who succeed in breaking the hegemony of the positivist approach in research design as an autoethnographic inquirer and as a teacher/educator guided by a student-centric pedagogical approach. As this study is based only on the researcher's experiences and perceptions; my study is unique as it covers the experiences of 6 people. My study is different in the ways of data collection methods and their interpretation.

By the same token, Wagle (2021) has conducted PhD research entitled "Place Pedagogies, Eco-Spiritual Cosmologies, and Cultural Stories: Wisdom from Dharmashala". The purpose of this study was to explore the ways for place-informed lifeful teaching and learning at school. This study adopted PAR as transformative practitioner research as a methodological stance. I found this study is more aligned with eastern philosophies where he chooses the PAR model as researching ecological wisdom in practice. In this study, the researcher began with the idea of how he adopted PAR as transformative practitioner research, and how it informed artful inquiry and empirical research through a metamodern ecological worldview and meta paradigm. The research site of this research was a community school in a nearby district of the capital city of Kathmandu. This study was based on three different action-reflection cycles and experiments with participatory and generative approaches. This study revealed that the action-reflection cycles motivated teachers to work on a participatory and generative model of emplaced pedagogies but some root constraints like the habituated classroom structures, bureaucratic linearity, and 'teach and learn for exam' didn't allow the initiation to become an integral part of the routine behavior of the school. The PAR team in this study observed that those constraints further strengthened and trapped them in the mess of ecological ripples. I considered this study as a referent study for my research. Though I have also adopted

PAR as one of the methodological stances in my study; my study is different in cultural settings of our context. My research is conducted in a private secondary school in the capital city whereas this study was conducted in a community school in a rural location.

In addition, Dhungana (2022) has conducted PhD research on the topic "Developing a living model of professional development of school-teachers in Nepal: A collaborative epistemic journey" to develop a living model of TPD to explore and nurture harmonious professional learning spaces in public schools. She has adopted a multi-methodological research stance in her study. The multi-method research design contains two major qualitative research approaches PAR and autoethnography and is named 'participatory autoethnography'. She has used the metaphor of '*Ardhnarishwor*' for her living theory methodology (Dhungana, 2020). In this research study the research concluded with four authentic strategies for developing a school-based living TPD (Teachers' Professional Development) model as her insight. In addition, she has explored the importance of critical self-reflection through which a teacher can self-access or self-judge to decide what is in/appropriate or right/wrong in their context. This study was helpful for me to get methodological insights into multi-method design. I was also open enough with my co-researchers for the critical self-reflections to explore the best-fit pedagogical approach in our context. Though my study seems similar to this study in methodological stance, the context of my study is different than hers. I have chosen a private secondary school in Kathmandu valley whereas this study was conducted in a community school in one of the nearby districts other than Kathmandu valley.

After reviewing the literature in the online database and my university library, I found that the STEAM approach is an evolving approach in our country and probably in other countries also. I found an insufficiency of evidence about the applicability of STEAM approaches in school education. This scenario drives me to undertake a study on the implementation of STEAM pedagogy in schools. The research like Perignat (2019), Scruggs (2019), Jammie (2019), Manandhar (2021), Wagle (2021), and Dhungana (2022) are some examples of international and local studies which are related to my concern about this study in STEAM education. Though there are some research and works of literature in STEAM education, I found my study is unique, in the sense that such type of study has not been conducted in my context. The integration of the STEAM approach in secondary mathematics in Nepali

K-12 education is found as a matchless study and a unique topic from the cultural perspective of other researchers. So, I see the gap in knowledge and this research study will be a milestone in STEAM education in Nepal.

Encountering the Research Problem

In this section, I discuss the problems around the pedagogical context of mathematics in Nepal based on my experiences, local literature, and discussions with the participant teachers of this research study.

Drawing on our experiences as both teachers and students, we have observed that the approach to mathematics education at all levels is largely guided by traditional, lecture-based, teacher-centered, and linear methodologies (Shrestha, 2018). However, this pedagogical approach has not produced the desired outcomes for mathematics learners and has resulted in a high level of disengagement among students. We can see the pathetic situation in the achievement of students in mathematics from school to university level. Similarly, by examining the past performance of students in SLC (School Leaving Certificate) and SEE (Secondary Education Examination), especially in mathematics, we can perceive the current state of the math education system in schools, which remains woeful (Manandhar, 2018, p. 20). Mathematics is a subject that was considered a difficult one in the context of Nepal (Luitel & Pant, 2019). The data provided by the National Examination Board (NEB) on the achievement of students in mathematics in the Secondary Education Examination (SEE) exam of the years 2017, 2018, and 2019 shows that 11.37%, 7.59%, and 7.33% of students respectively have got A and A+ grades and high percent of students are not able to secure satisfactory grades. According to the Educational Review Office (ERO) report (2019), achievement in mathematics is a minimum among the other subjects at the secondary level.

In my experience as a mathematics teacher also shows that students are less motivated toward mathematics learning. Students are developing negative attitudes towards mathematics because of its abstract and ugly nature in our school curriculum. Students feel like they are solving the problems of textbooks only for the teachers, parents, and for the grades in their report cards. We (as teachers) are not able to make them feel like they are solving their own real-world problems through mathematics because of the decontextualized nature of mathematics. The dominant pedagogical approaches in our context like rote memorization and recall, and algorithmic problem-solving strategies make mathematics learning as unproductive area and not able to

address the interest of 21st-century learners. They take mathematics as a foreign subject as argued by Luitel (2009). This approach to teaching and learning mathematics is devaluing students' creativities and critical thinking which leads them to think beyond the textbooks and curriculum criteria. The most responsible stakeholders of education i.e., teachers are reluctant in learning new strategies and to adopt the contemporary methods in teaching and learning mathematics because of that they are reproducing the same knowledge in the same way how they have learned which is not able to address the expectation of todays' learners. The authors like Luitel (2012), Pant (2015), and Shrestha (2018) have also put reflected on the decontextualized nature of the Nepali mathematics curriculum.

Further, the one-size-fits-all pedagogy and transferring the knowledge from teachers' heads to students' heads prioritized lower-order cognitive thinking skills in Nepali learners. The majority of the teachers are using conventional pedagogies where a teacher just delivers the content from the textbooks to finish the course content with very less use or no use of educational aids which leads to poor understanding in the concern areas, and it creates frustrations in the learners. Likewise, the structured classroom environment and positivist nature of the teacher also matter in our mathematics learning. Our practices of mathematics teaching and learning are like a training camp in security agencies where one needs to follow the instructions of the leader or instructor without any objection. This scenario of classroom environment hinders the students' creativity and compromises them to reproduce the same knowledge delivered by the teachers.

Likewise, my experience and the interaction with the mathematics teachers in my study location show that they are not reflective in their practices and reproduce the status-quo. As they do not reflect on their practices and pedagogies, they are less aware of the modification and implementation of new ideas. Because of the lack of critical self-reflection teachers in the Nepali context are promoting teacher-centered, culturally detached, disengaging, and so-called traditional way of teaching-learning activities. Critical self-reflection has been kept at the center of transformative pedagogy, I found very few teachers in my research cite are aware of this approach.

The above scenario shows that transformative STEAM approaches are observed to be significant to promote progressive teaching-learning activities. As a STEAM practitioner and an educator, I believe that this scenario of dissatisfying achievement and students' anxiety towards mathematics can be minimized through

the integration of real-world practices which can touch both the cognitive and affective domain of the learner. In my opinion, the STEAM approach which itself consists of multi-disciplinary and trans-disciplinary ideas might do justice to teaching and learning mathematics. STEAM has been considered one of the transformative learning approaches (Mehta et al., 2019). As our country is advocating for interdisciplinary and transdisciplinary integration in the K-12 curriculum and already started the practice of integrated theme-based curriculum for grades one-three (Curriculum Development Center [CDC], 2019) shows the essence of STEAM education in all grades probably in the near future. As suggested by Fogarty; the integrated curriculum model involves collaboration among teachers from various disciplines to identify shared concepts and design cohesive units of study that blur disciplinary boundaries (Kysilka, 1998). We are practicing a theme-based teaching and learning approach in these elementary grades. The learning approach of STEAM Education helps students to gain skills that are essential for the 21st century (Kandel, 2018). The STEAM approach helps students to make meaning by linking different disciplines through the connection of Arts (Henrkisen, DeSchryver, & Mishra, 2015). The design of the STEAM-based activity not only fostered the creativity of students but can develop a prototype to solve the problem of the user in the real context. In this context, this research study will advocate the necessity of STEAM pedagogical innovations in teaching-learning mathematics in the Nepali context. For this, we (the PAR team) critically reflect upon our practices and come to an action plan for implementing innovative practices. With the aim of integrating different disciplines into the same basket, we delve into the research context and come out with its impact and impressions on our professional journey.

Purpose of the Study

As a researcher, I aimed for two purposes in this research study. The very first one is to critically reflect on my pedagogical practices as a STEAM teacher and an educator. The second purpose of this research study is to explore how STEAM pedagogy helps me (as a practitioner-researcher, teacher, and teacher educator) and my co-researchers (teachers) at the secondary level improve our pedagogical and professional practices.

Research Questions

This study is guided by two main research questions followed by its sub-questions:

1. In what ways did my academic experiences develop me as a potential transformative learner, teacher, and teacher educator?
2. How did STEAM pedagogy help me and my co-researchers improve our pedagogical practices of secondary mathematics?

Subsidiary Emergent Research Questions for Research Question 2

a. How did the PAR team plan and initiate the STEAM pedagogy in their context?
b. How did the PAR team-initiated collaborations and negotiations work for the STEAM implementation? And, despite the hopeful perspectival transformation, how the team experienced manifold messiness while implementing it?
c. In what ways did STEAM practices make our (PAR team) classroom harmonious and affective driven?
d. How did the PAR researchers develop their pedagogical perspectives/ practices for transformative sustainability?

Though I have presented all the guiding research questions in the above section, it is not true that I have got the insights of all these questions at once. It is again true that I was having tentative guiding questions at the beginning, but the research questions got modified and changed based on the collaborations with my co-researchers which I have discussed in Chapters II and V.

Significance of the Study

The study is expected to provide helpful information for teachers, educators, and policymakers to promote the STEAM environment and practices in secondary-level education. The results of this study could be helpful to inform secondary school teachers about the STEAM integration in teaching and learning secondary mathematics. My lived experiences from the autoethnographic section or the STEAM intervention in the PAR context; both the forms can give a clear picture of a transformative STEAM practitioner. As our educational practices are guided by conventional lecture-based strategies; this study might cultivate a new practice that could be adopted by other teachers to connect secondary-level mathematics to the learners' real-life context and design STEAM programs to solve their problems. This study might throw light on the experiences and practices of STEAM professional

teachers at the upper school level, so that the teacher and educators may select the appropriate teaching methods and techniques which can make the students' learning meaningful.

As a transformative learner and educator, this study makes me more aware of the implementation of STEAM pedagogy in my context. In addition, the co-researchers of this study also transformed themselves from so-called traditional teachers' practitioners to STEAM practitioners. We all (the PAR team) have got a chance to implement our best practices in an integrated form for the holistic development of the learners. This study helped us to explore our creativity which involved both the teachers and students in the learning process.

Chapter Summary

I have presented a scene for my study in this chapter that works as a background for me to continue this journey further. The background section of this chapter helped me to set the scene of my context. In addition, the problem statement set the agenda for this study. This section makes us realize that the issue and the purpose set by this study are genuine and need to be explored in our context. The research questions were explored from the context and the answers to those questions were addressed from the intervention in a school. In aligned with this chapter, I have set the pillars of this study in the next chapter (Chapter II). Those pillars are the set of literature and theoretical orientations that guided me in each to build this research study.

CHAPTER II
CONSTRUCTING THE PILLARS OF THE RESEARCH STUDY

Chapter Overview

I believe that the existing literature is the pillar of any research study. In this section, I have reviewed various kinds of literature that help me in shaping my study in this form. It includes a brief review of literature related to STEAM education and its implication in teaching pedagogy of secondary mathematics. I reviewed articles, journals, and dissertations based on STEAM education, STEAM pedagogy, the role of STEAM in mathematics, and literature related to secondary mathematics education through a different perspective of the different contexts. Not only this, but I have also explored the research related to autoethnography, action research, and participatory action researcher in shaping my goals in this study. The literature guided me on track to get my objectives. I have discussed this chapter under the headings like STEAM education and STEAM pedagogy, the role of interaction in mathematics learning, and the inevitability of Arts in Mathematics: is a mathematics teacher an artist? Designing STEAM Curriculum: Trans-disciplinary approach, and some theoretical underpinnings like transformative learning theory, and Habermassian knowledge constitutive interest.

STEAM Education and STEAM Pedagogy

Being at this stage, I found STEAM education and STEAM pedagogy can make a transformative shift in the educational practices of Nepal. As a STEAM learner and a practitioner, I found this educational practice can shift the educational paradigm from a teacher-centered approach to a learner-centered approach; from a knowledge-centered to a skill-centered approach; from a theory-centered to a real-life-centered approach; from positivist to art-based approach. In the earlier chapter (Chapter I) I have reflected on how I was brought up and how I used to practice the pedagogical dimensions as a learner and a teacher. I even shared my lived living experiences with the evidence in the form of stories in Chapter IV; these autoethnographic stories are the evidence that reflects me and my images for the readers. I found the integrated STEAM approach was derived to fulfill the need and demands of the 21st-century world. It is an approach that brings multi-disciplines

together to take a holistic picture of education which can address the actual need of the learners' context.

Before the integration of Arts in STEAM, the STEM was focused on Science, Technology, Engineering, and Mathematics which has no space for art-based pedagogy, it was introduced in the 1990s as a way to improve academic rigor in four discipline areas that can equip learners with 21st-century skills (Bybee, 2013 & Quigley et al., 2017). Similarly, Liliawati et al. (2018) also argued that this approach "is an extension of Science Technology Engineering Mathematics (STEM), by including the Art element which is a positive, rich, and powerful element in civilization and many ways can take a decisive position" (p. 1). The integration of Arts helps students in learning science through communicating different means of demonstration such as visual performance, text, narratives, and others (Henriksen, 2014). According to some researchers, such as Hero and Quigley (2016a), and Land (2013), the definition of STEM is overly limited and does not sufficiently emphasize the development of 21st-century skills as attainable learning outcomes.

In my opinion, the practices of STEAM education are the change agent in our scholastic practices. I even experienced this through PAR, which is one integral domain in this study. It promotes and supports interdisciplinary and multidisciplinary approaches in teaching and learning; the integrated curriculum of the early grades in our country could be an example to connect the academic ideas of one subject to another and the learner's real-life scenario.

STEAM consists of transformative curricula and a pedagogical approach (Mehta et al., 2019) it is not only to advocate for the integrated curriculum but to take the necessary steps towards meaningful teaching and learning (Stroud & Baines, 2019) which has already gained popularity as an educational movement around the globe (Liao, 2019) and is in the incubating phase in Nepal. Though our educational system is highly dominant by the orthodox teaching and learning practices, I found some schools and teachers practicing their business differently; some were practicing songs/dance to memorize the multiplicative table and formulas whereas some were focusing on paper cutting and designing the concrete objects to clear the mathematical concepts. It is clear that those practices were not enough to implement STEAM pedagogy in mathematics education, but I found their unique style of teaching and learning mathematics among the status quo of our system is a revolutionary practice.

I am using paper folding and paper cutting in teaching mathematics.

I am using concrete materials from the market.

I sometimes take my students to the TV room for the videos on YouTube.

I engage my students in making designs.

One of my fellow teachers from another school revealed this during our informal conversation. As an educator, I experienced that many of our institutional and community schools mostly in urban areas and some in rural are practicing STEAM pedagogy with their self-designed STEAM curriculum based on the central curriculum, which shows that "Nepal is in the process of transforming school education by reforming curricula, textbooks, and education policy for more integrated education at the basic level and transdisciplinary relations at the higher level" (Belbase, 2019, p. 1). But when I visited a few schools in the earlier phase of this study, I found very few of them had aligned their pedagogical shift towards this innovative approach. Then I thought what if I practice the STEAM approach in my working station collaboratively with the teachers of other disciplines. This was the striking point for me to rethink my research agenda and I came up with my second research question:

How does STEAM pedagogy help me and my co-researchers improve our pedagogical practices of secondary mathematics?

Yes, now I can experience myself delving into the STEAM pedagogical approach and can share my living experiences. I found that this experience in my autoethnographic inquiry can add a different flavor and also can contribute a different dimension to Nepali scholastic practice.

The National Curriculum Framework of Nepal (2007) emphasized an integrated curriculum for Grades one to three in school education (CDC, 2007) which directs our educational practice towards transformative curriculum and transformative education. The pedagogical practices in the majority of the schools I visited were guided by compartmentalized teaching and learning approach. Though they claimed themselves as a STEAM practitioner school, I found few of them are approaching this notion. Being a researcher and a practitioner, this was like a spark for the light of STEAM practice in the Nepali educational system.

As this study incorporates the STEAM practice in teaching and learning secondary mathematics; I found some of the teachers and educators are endorsing pedagogical strategies of transformative STEAM education in their classroom. The

teaching/learning activities by embracing Arts-based methods of dramatic storytelling, narrative reflective writing, and dialectical reasoning are making the mathematical concepts understandable and learners' friendly. They are transforming themselves and their learners by making acquainted with different pedagogical theories and perspectives developed in STEAM education concerning STEAM pedagogy in mathematics teaching.

The transformative STEAM curriculum puts emphasis on making socially responsible students which gives space to transformative pedagogy nurturing and equipping students with skills to think and reflect critically; giving values and empowering them for environmental justice (Radziwill, Bento, & Moellers, 2015). The artistic components in STEAM help the learner to emerge in such a situation where "meaning occurs through the process of exchange, and interactivity itself is the very medium of the work" (Muller & Edmonds, 2006, p. 147) which shows that a learner can learn by reflecting on own experience through art and can modify the own practice as per the need. We as a participant in this study also practiced curtained art-based pedagogies like role play, drama, songs, poems, and dance as a pedagogical approach.

Integrating trans-disciplinary skills in secondary mathematics involves the young learners analyzing critically their cultural aspects, and "…engage empathically in real-world ethical decision-making scenarios, contemplate their spiritual connection with the natural world, and develop their moral agency for making the world a healthier and happier place in which to thrive" (Taylor & Taylor, 2019, p. 2). Furthermore, STEAM courses and envision curriculum with transformative intent for the K-12 education system in Nepal considering "…curriculum as local enactment, power-sharing, cultural reconstruction, to promote culture-sensitive perspectives" (Luitel & Taylor, 2005, p. 2). I strongly believe that STEAM pedagogy not only transforms our educational practices but makes the classroom and learning livelier and context friendly.

Role of Interaction in Mathematics Learning

Mathematics is one of the important subjects (Hodnova & Nocar, 2016) in the school curriculum. Mathematics is a compulsory subject up to Grade X in Nepal. As I have discussed earlier (in the problem statement section) school students are not showing good performance in mathematics which is seen in the results of board exams like SLC/SEE and grade eight. There could be various reasons but, from my own past experience as a student, I think the lack of interaction between teacher and student is one of the major causes.

Figure 2.1

Students working in collaboration

When I was a student, my mathematics teachers used to follow the traditional teacher-centric approach. We were not allowed to collaborate with bench mates in the running class. We had to maintain pin-drop silence in the class. The math teacher used to share the content and solved the problems on the board; we were not supposed to ask any questions. We just listened to the teacher and passively copied all the written answers from the blackboard. I could see some of my friends tried to ask questions sometimes, but the teacher's humiliation knocked them down forever.

You are also asking questions?

You don't know even this?

How did you reach this grade?

You must be somewhere else in junior grade.

I am not here to answer those silly questions.

Please go and consult with your younger brothers and sisters.

If I remain stuck in such basic concepts then how can we cover the course in time?

You all are in the same class, if all have understood then why you haven't?

Such question in return from the teacher rather than answering the student's question hinders their questioning skills. I experienced that the students in my context were forced to remain silence. We were expected to solve the problems from the exercise by following the solution procedure of our teacher. We have been told that

mathematics learning is an individual product only those students who do repeated rigorous practice achieve mathematics fluency. Teacher-led instruction is still one of the influential factors in students' poor performance not only in Nepal but in most Asian countries (Cheng et al. 2019).

Joining Kathmandu University has opened my eyes and changed my belief and perspectives on mathematics learning. When I applied innovative teaching and learning approaches in mathematics education that I tested in self-learning and teaching to my students I realized mathematics learning is the product of social activity (Cobb et al., 1997; Sfard, 2001). I found student-centric approaches such as collaborative learning and peer learning helpful for students to develop their reasoning skills (Lithner, 2008). According to Yadav (2017), collaborative learning in mathematics helps students to understand and perceive subject matter more effectively. In collaborative class, the discussion of the students in ideas helps them to solve a mathematical problem from multiple perspectives. I can relate the advantages of collaborative work from my own experiences as a learner in M. Ed. and MPhil studies. In doing this I might be guided by the socio-cultural theory that knowledge is constructed from social interaction. In other words, knowledge is embedded in society, and it can be obtained from co-construction or interaction. This collaborative approach guided by social learning theory promotes a holistic approach that can connect the learners to the real-life context.

The learning environment is important no matter which subject has been taught. I have observed in many math classes followed by, so-called well-disciplined approaches, strict rules, and regulations inside the classroom, such as pin-drop silence which kills students' communication and other social skills. It might seem a good and effective classroom for an outsider and the outsider sometimes may praise such a teacher and give him/her a tag of a perfect teacher. A tagged teacher can maintain discipline by giving no space for peer learning and group learning.

Maintaining discipline in a classroom is one part but at the same time, the teacher should be aware of matters of giving space to students, where students are at the center of learning. I have also shared my experiences (in Chapter IV) of learning in such an environment and again creating a similar scenario as a teacher. The question arises as, to whether the students are getting enough learning environment inside the classroom or not. Are they engaged and understand the concept or not? One of the reasons behind the calm atmosphere inside the classroom could be the fear and

anxiousness of students who are bound by the so-called well-disciplined classroom rule. Sidabutar (2016) stated that interaction between facilitators and learners is crucial for quality education and meaningful learning. In a student-centric classroom, one should provide a favorable environment for good interaction between teachers to students or student to students, so that student can clear their doubts if they have any. Logical arguments with classmates and the exchange of ideas with bench mates foster the reasoning and computational skills of students. Interactions stimulate the senses and encourage students to learn creatively and innovatively (Pianta, 2016). Meaningful interactions have been found beneficial in the conceptualization of mathematical ideas.

The Inevitability of Arts in Mathematics: Is Mathematics Teacher an Artist?

In a time of innovations and technological advancement, an educator or an educational stakeholder has the challenge to shape the students for the future perspective as a progressive leader equipped with 21st-century skills to be responsible citizens (Ge, et al., 2015). To serve future needs and to produce compatible citizens with cultural and ethical values towards their own society and nature; a new approach to education 'STEAM' comes into existence. I have collected the picture attached on the side from a drawing book of any student. I know that any form of art can express the feelings and emotions of the artist.

Figure 2.2

Art found in student's art-book

As far as I found, the STEAM approach is derived to connect the abstract ideas of our textbooks and curriculum to the learners' real-life context; as a streamlined and productive method of combining the arts and imagination with STEM education efficient and effective way to merge the arts and creativity with STEM education (Daugherty, 2013). Yakman, an early founder of STEAM pedagogy promotes the idea of interdisciplinary and multidisciplinary approaches in teaching and learning; the integrated curriculum of the early grades in our country could be some examples to connect the academic ideas of one subject to another and the learner's real-life scenario. For me, interdisciplinary refers to the integration of different topics or areas within the subject whereas multi-disciplinary refers to the

integration of different subjects but still the components of each subject can be visible. On the other hand, the transdisciplinary approach for me is a holistic approach that does not set any boundaries for the disciplines. It might be a boundaryless integration. The integrated curriculum is supposed to be an integration of the curriculum content into the learners' real-life context. I believe that our real practices and problems are not limited to a single concept but require multiple lenses and ideas to tackle and solve it. This scenario gives rise to new curriculum practices which promote theme-based learning and i.e., integrated curriculum practice. Moreover, integrated curriculum practices integrate previously separated STEM disciplines along with arts. But before any successful plan for the integrated curriculum by a teacher or any institution, they must have a clear concept of what 'integration' here means (Kysilka, 1998). Fogarty (1991) has described ten models of curriculum integration which begin with an exploration within a single discipline, continue with models that integrate several disciplines, and end with models that operate within learners themselves and finally across networks of learners. The author added that "the connected model of the integrated curriculum is the view through an opera-glass, providing a close-up of the details, subtleties, and interconnections within the disciplines" (Fogarty, 1991, p. 61) and students will be able to understand this connection themselves. The future curriculum might be concerned and based on an integrated model as it examines the priorities that overlap multiple disciplines for common skills, concepts, and attitudes of the learners. The integrated model of education perceives the curriculum as a kaleidoscope, where interdisciplinary subjects are reorganized based on common concepts and emerging patterns to form innovative and cohesive designs (Fogarty, 1991).

The integration of A (Arts) with STEM results STEAM serves the STEM disciplines as well as other learning opportunities for the students through arts and designs. "The integration of arts promotes not only students' cognitive growth but also emotional and psychomotor growth, strengths their critical thinking and problem solving, cultivates their creativity and encourages self-expression" (Ge, Ifenthaler & Spector, 2015, p. 385). Taylor (2016) has mentioned that the integration of Arts in STEM has added a new dimension to the interdisciplinary curriculum for educating all humankind. Arts have been described in many forms, and the arts in STEAM education have many features. And lately, it has become an important component of the STEAM framework. Previously STEM was focused on academic subjects to

enhance students' life skills, but latter 'A' added moral and ethical values to live together in this world.

The world is artistic. We have different forms of arts in our practices like fine arts, language arts, physical arts, manual arts, liberal arts, and so on. In my opinion, knowingly or unknowingly each individual is aligned with some kind of art. I can even notice an early-born child who cannot even speak a single word can have a sense of music; he/she loves the actions of the people surrounding him and feel happy in many other artistic activities. We have a tradition of telling stories and singing songs (*lories*) for the children in their early ages which make them soothe and get sleep. The majority of people cannot deny the importance of art in their life to keep them happy.

Conventionally, arts were taken only as a subject matter which needs to teach and learned in certain educational institutions. I have seen many students and teachers practicing and doing their jobs in this field but in today's scenario and from the perspective of STEAM education and arts can be taken as an orientation that shows the designs and arts in our spatiality and it can also be taken as the representations of one's culture and practice. "The arts have a way of capturing the essence of an endeavor, reframing experience, and transforming perceptions" (Stroud & Baines, 2019, p. 1). Arts can also be considered as a process of self-reflection and communication, in which one can critically reflect on own practices. Arts can also refer to the product of items and materials along with their accomplishments and impact on society. In the case of mathematics education arts is taken as a means which gives soul to the body of calculations and abstract ideas. Adding Art (A) in STEM helps students to get ready with essential skills and other ethical values. It can foster the inherent imagination and curiosity to build life-applicable designs and tools. "As with arts, at its core, scientific investigations are predicated upon curiosity and creativity" (Stroud & Baines, 2019, p. 2). The important concept of sustainability, nurturing planet, and environmental justice, followed by ethics can be transferred by the STEAM educators to the learners (Taylor, 2016). The STEAM approach helps to embed creativity, curiosity, and critical thinking skills in an integrated manner. Therefore, a mathematics teacher needs to prepare own-self and needs act like an artist to integrate arts into the mathematics classroom and to teach artistic mathematics.

I have presented my stories at the center of a naturally artistic place but no interaction with it in the educational journey. Being a part of the PAR team, we

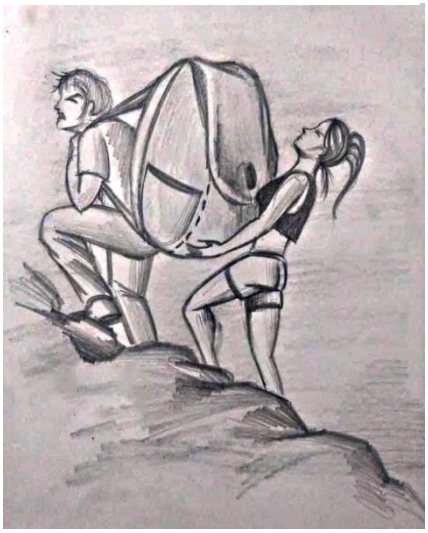
integrated some artistic pedagogical approaches, like songs, dance, performing arts like role play, and so on during this study. We as teachers just guide the students in this way and they create different forms of arts in learning the contents which I have discussed in upcoming chapters.

Designing STEAM Curriculum: Transdisciplinary Approach

The curriculum is a plan for the educational program. It can also refer to the planned activities of the educational programs prepared by educationists and experts involving needs, children's interests, teachers' experiences, and many more to reach the goal or the desired goal in education or any other faculty. Similarly, I also think of curriculum as the bridge which can connect educators to scholars through any subject matter. Most people outside the education milieu think of curriculum as the course of study in a classroom. This is the common definition that can be interpreted by most people and even my pre-existing schema was the same as this before joining the course of curriculum for the first time in my Masters study.

Figure 2.3

Metaphorical picture for content-loaded curriculum



Designing a curriculum is a very crucial task and designing a learner-friendly and contextual curriculum that can address the global need is more challenging. In this regard, Mohanasundaram (2018) argued that we need to be aware of four things while designing the curriculum "Why do we initiate instruction or aims, what should we teach to realize our set aims and objectives, how can we interconnect target learning experiences, what have we realized and what actions should we take accordingly concerning the instructional program, learners, and teachers" (p. 1). I have considered those points while designing the STEAM projects for the PAR study in this research. But our content-loaded curriculum (the picture attached reflects this metaphorically. I got this picture somewhere in social media), 'teach for marks' approach, and informing pedagogical practices rather than transforming approach can be the constrains in some cases.

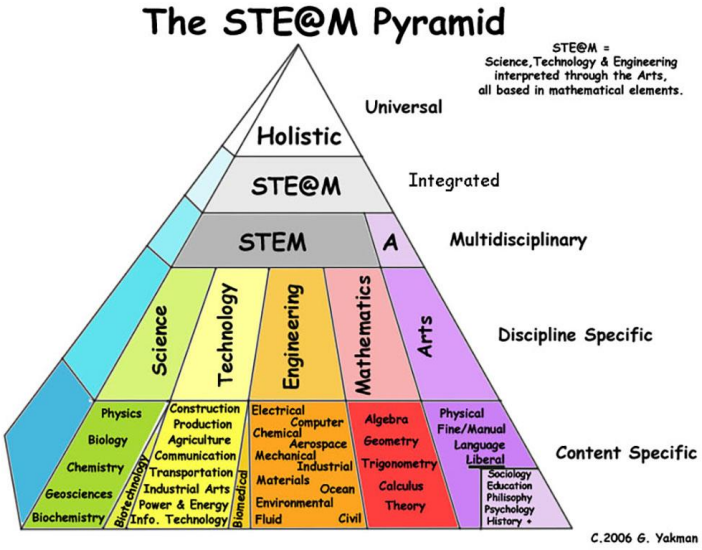
The world is changing day-by-day and it is very difficult to catch and serve the current need of this world and the 21st century. To minimize the gap between the need

for 21st-century skills and our educational practices; the STEAM curriculum can play a vital role. In designing the STEAM curriculum, I have proposed a model here designed by Yakman (2008) which is also known as the Yakman curriculum pyramid. Georgette Yakman has conceptualized this model by integrating Arts into the STEM disciplines. It is found that the compartmental knowledge produced by STEM subjects is not sufficient to fulfill the need of 21st-century citizens. As we can see the integration between different disciplines like mathematics can be closely connected with language arts and engineering or can be integrated with other disciplines also. This model advocates for the commonality practice of learning areas of the learners. Her aim to purpose this model was to structure the area of study "that would allow students to understand the importance of the relationships of the fields and hopefully come to respect their need to acquire skills in all areas if they were to become well-rounded citizens" (Yakman, 2008, p. 15).

Additionally, she aimed for such a structure in the educational field that could interconnect different fields of study and would not establish a hierarchy in scholastic fields (Yakman, 2008). While integrating STEAM silos she reveals that "mathematics is the primal language that cuts across all other field's boundaries" and considers mathematics as the underlying language of all communication (p. 17). Mathematics serves as a bridge between concepts and comprehension in education. It is believed that the disciplines of science, technology, engineering, and arts can be expressed through the language of mathematics. The arts and engineering encompass all the aspects that collaborate with the pure potentials of other fields, thereby directing the progression of growth. The model can help to find cross-curricular subjects which can be integrated with other disciplines.

Figure 2.4

The STEAM Pyramid



(Yakman, 2008, p. 17)

The above pyramid shows the model frame through which Yakman purposes her ideas in STEM integration with Arts. The pyramid starts from the top of holistic education or the universal level where a learner learns any idea without knowing its compartmental idea, i.e., one can learn the situation which happens to him/her. Such type of knowledge cannot be planned or avoided and is not categorized as science, math, engineering, or anything next. She argues that the results of these influences, the learner both cognitively and affectively and create life-long learning.

Similarly, the second level of the Yakman model which is known as the integrated level is the level where "students begin to understand the educational realm and can gain a comprehensive understanding of all the fields and a fundamental overview of the subject of study" (p. 18). At this level of the pyramid, all the STEM subjects together with arts are connected to form interdisciplinary subjects. Though she argues this STEAM approach benefits all educational levels, linking the second part of her pyramid is appropriate with the primary and secondary levels. We have also integrated different disciplines to create STEAM projects for the action plan in this study. Our aim to blend those chapters under a common theme was to create a holistic picture to be learned for the learners.

Likewise, the third level is named the multidisciplinary level where the learner can acquire a range of precisely selected areas and can connect them to their real-world practices. She argued that the current trend in education has a huge and established focus on STEM subjects and marginalized the importance of arts in it. Further, she emphasized that education with a specific theme can be designed at this level, which is relevant to middle-school education. At this stage, students can grasp the hierarchy and dynamics of both education and practical applications, and being to delve into their area of interest.

The fourth level in the pyramid is concerned with the discipline-specific level, "where individual silo divisions of fields, or disciplines, are taught at focus levels" (Yakman, 2008, p. 19). This level of education highly focused on the wishes and currier which explore the expertise of a person. She has linked the fourth level of the pyramid to be most applicable to secondary education.

The fifth or the last level of the pyramid is content-specific where a learner can learn specific content areas in detail. The content-specific level helps the learners to get expertise or specialize in a particular field. This level is also considered the professional development level, where students' focus remains on their interests and the content. She has linked this fourth level of the pyramid as appropriate to post-secondary education. This level helps to generate a skillful citizen who can sustain in his/her real-life context. Further, she argues that this level needs to be contextual and practice-oriented where the development of students is at the core.

My Theoretical Lenses of Research

This section consists of the theoretical perspectives of my study. In this section, I, as a researcher, have connected different theoretical ideas related to the construction of knowledge of STEAM pedagogy with the supportive literature. "The theories are the bases on which the ideas can be presented" (Shrestha, 2018, p. 31). In another sense, I can say that these theories are the means for constructing knowledge in the present study. This research is designed in a participatory autoethnographic research design where I incorporated the experience in practicing the STEAM approach of the researcher (myself) and my co-researchers (teachers) in the field. The knowledge constitutive interest of Habermas guided me as a STEAM practitioner teacher and an educator to observe the real-world phenomena and extract the teachers' emancipation and empowerment from the context. In addition, transformative learning theory also guided me both as an autoethnographic inquirer and PAR

researcher. The details of how I am guided by these theories in this research study are discussed down here. The question may arise: why I chose two major theories in this research study? I have answered this question in the subheadings below.

Knowledge Constitutive Interests

Jurgen Habermas's knowledge of constitutive theory guided me in this research study. The three cognitive interests developed by Habermas (1972): technical, practical, and emancipatory interests are the pillar of knowledge constitutive theory (Grundy, 1987; Taylor & William, 1992). In this research study, I am guided by two of its pillars i.e., practical and emancipatory interest.

The practical interest is based upon constructing knowledge together. Here interaction of the people, subjectivity, context, and consensual understanding are highlighted. This interest conceives knowledge as a process of social interaction to generate understanding and sense-making (Grundy, 1987). This interest is guided by the Historical hermeneutic perspective. Inside the classroom the interaction and different perspectives of learners have emerged during class group works, peer work, and class discussion, valuing what students have already known and accepting their decisions, providing equal opportunity for sharing is essential. Being a mathematics facilitator, I believe that the outcomes of discussions, or learning processes required lots of interaction tasks and activities where knowledge is being constructed through consensual understating of students. The first principle of constructivism also states that "knowledge is not passively received either through the senses or by way of communication but is actively built up by the cognizing subject" (von Glaserfeld, 1990, p. 83). In this research study, the STEAM approach looks for all these consensual understandings and interpretations. Here, I accept all my participants as co-constructors of knowledge. I value their perceptions and understanding and allow enough interaction for the meaning-making process.

The Emancipatory interest promotes social justice and equitable being. Moreover, this interest in "counter-hegemonic concerns" empowers the teachers and students from the disempowering forces of "ideology, or dominant ideas and values" (Taylor & Williams, 1992, p. 6). To bring justice and promote equity a person needs to be a change agent who can encounter false consciousness. Society has rooted certain beliefs and grounded norms to emancipate from own perception and thoughts to create freedom for a self-emancipatory interest is needed. Here praxis plays a vital role in reflecting critically on their ongoing practices. In school students' self and

critical reflection upon their thought and actions, raising their voice against societal unjust will promote critical consciousness among students.

As an autoethnographic enquirer, this theory guided me in my self-empowerment (probably of the readers as well who are from similar context ad experiences) through the critical self-reflections. The stories and episodes I collected in Chapter IV are the evidence that visualizes my past and present scenarios and shows my transformation. These reflective narratives are the frames of reference for me to modify my pedagogical practices and establish myself as a better version of a teacher, educator, and researcher.

On the other hand, being a teacher and researcher, I can promote teachers' and students' emancipation during classroom learning (Grundy, 1987). Doing so, I throw light upon the basic practices and experiences of teachers and students through participatory action research where every student and teacher is valued which can bring the feeling of responsibility and autonomy for the intervention. During the implementation period, teachers were given the freedom to share their ideas and collaborate with teachers of other disciplines in designing their integrated plans. The empowerment and transformation of the teachers were observed from in/formal discussions, interviews, and written reflections. The emancipations of the participant teachers through this intervention are analyzed and discussed from Chapter V to Chapter VII.

Transformative Learning Theory

I found that research that has a transformative goal for the participants, researcher, and society is transformative research and guided by transformative learning theory. This research study is also directed towards the transformation of the researcher, and the participants; in this way, transformative learning theory guided me to conduct and in the documentation of this study. In addition, it is true that "…transformative research is a means of achieving change at a community and institutional level. However, transformation can also take place on a personal level; and indeed, the argument can be made that transformation at any level has to begin with the transformation of the individual" (Walton, 2014, p. 30). My autoethnographic inquiry helped me to critically reflect upon my deep-seated, traditional, and hegemonic pedagogical beliefs and practices arising from various un/helpful socio-political, and cultural phenomena. This inquiry helps me with my self-transformation for a better self. Those critical reflections upon my practices and

set of beliefs create disorienting dilemmas which challenge the current meanings of my practices and beliefs. These challenges and questions towards myself help me in the development of new or modified forms in my beliefs and that reflect my practices which motivate me to integrate new meanings and perspectives into my personal and professional journey. The thirst created through such reflection and motivation helps me to modify my pedagogical practices that come in the form of PAR in this study.

In addition, transformative researchers "draw on constructivist, critical, social and arts-based epistemologies to examine reflectively, critically and imaginatively their lived experiences revealing the historical and sociocultural framing of their personal lives and professional practices" (Taylor, 2013, p. 2). This theory guides me to explore the teachers' transformation as a primary participants of this study, and students' and school's transformation as a secondary participants in this study. The shift in the pedagogical practices of the teachers and the school system in extracted through the reflections of teachers and students. In doing this, I as a researcher and a participant engage myself throughout the intervention time in the context of this study. As transformative learning theory guides me to dig the transformations on the "taken-for-granted frames of reference to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove truer or justified to guide action" (Mezirow, 1991, p. 133). This study acts as a change agent for the participant teachers (along with me as a participant and a researcher) and the participant school to shift their pedagogical practices.

Likewise, I have incorporated some other notions of transformative learning theories such as giving ownership and agency, and resilience in the discussion section. These components helped me assume to play the role of agency in the field (context of the PAR study) and resilience to bounce back as a researcher and a participant in a more mature form in every situation of the PAR study. I experienced that our collaborative plans might not work exactly in all cases and the team needed to modify the plan after each intervention. The three Es model (see Chapter III) for data collection technique (Experiencing, Enquiring, and Examining) helped us (me along with other participants) to reflect critically on our plans and modify them to find the best-fit plans and strategies for our learners and our context. The collected information is analyzed through the transformative lens in this study.

Chapter Summary

This is the end of chapter II which reflects the literature review section under four themes and the theoretical framework. Four themes in this chapter support the idea/essence of STEAM learning based on the existing literature. The themes like "STEAM education and STEAM pedagogy" advocate the need for the STEAM approach in educational discourse. Likewise, themes like "The inevitability of arts…" present the mathematics teacher as an artist. It advocates the importance and effectiveness of arts and artistic approaches in teaching and learning practices. The remaining two themes; "Role of interaction in mathematics learning" and "Designing STEAM curriculum…" helped us in developing the STEAM projects that were implemented during the intervention.

Similarly, this chapter placed two broad lenses of theoretical framing: Habermassian knowledge constitutive interests and transformative learning theory. These lenses were taken as references in designing the projects, during the intervention, and in the discussion of this chapter. The notions of emancipatory interest in Habermassian's theory helped us to reflect critically on our practices and beliefs that helped us to grow in our professional world. In addition, the transformative theoretical lens made us aware of the transformation of our practices and within us through this study. Now it is time to set the roadmap of this study. For this, the next chapter (Chapter III) constructs a methodological framework that guides me to accomplish this study.

CHAPTER III
CONSTRUCTING THE ROADMAP TO THE RESEARCH STUDY

Chapter Overview

In this section, the researcher identifies his research method. The section begins with a discussion of the research paradigm and the justification for choosing the paradigm. My philosophical stances and methodological approaches in this research study helped me to pave a path for resolving the issue of implementing participatory evaluation as a way to improve mathematics teaching at the secondary level of Nepali schools. While doing so, I intend to pursue the purpose and objective of this study by understanding and implementing Participatory Autoethnography (Autoethnography and Participatory Action Research: PAR) as a method of inquiry. The setting and the research site of this study are discussed including descriptions of the research participants. This chapter incorporates the method through which the information can be gathered for discussion and interpretation.

What Influenced my Choice of Methodology?

During my development as a scholar-practitioner through the M. Phil. Studying in STEAM education, I was taking both the courses; advanced qualitative research methods and advanced quantitative methods because I was interested in blending different methodologies in a single research study. Similarly, as a practitioner teacher and an educator, I have found that our existing pedagogical practices in teaching mathematics are less contextual, teacher-centric, and conventional. Such pedagogical practices are not able to address the need and interests of 21st-century learners which promote disengagement, less interest, and low achievement. This issue of pedagogical practice strike on my head and encourage me to study this issue. In the earlier days of designing this study, I was looking for a mixed method study where I would survey the first stage and later narratives of the STEAM practitioner teachers. For this, I have investigated the number of schools and teachers who claim that they are using STEAM pedagogy in their teaching and learning styles. In doing this I have found that very less (insufficient for the survey) schools and teachers are only familiar with this approach. On the other hand, I was not able to find enough local literature on STEAM-related research in my concern

methodology. This scenario enables me to rethink my issue and found that participatory autoethnographic study could address my mythological stance.

Likewise, I had always been mathematically minded might be because of my mathematical background which always encourage me to see/observe any phenomena from both (quantitative and qualitative) perspectives. I was a convert, having had some good knowledge of mixed methods study from my previous degree (M. Ed. in mathematics), which always encouraged me to use multiple genres of methods and paradigms in my research study. I believe that a combination of different methods and genres can contribute to a better understanding of a research problem and the essence of the study as compared to research that is based on only one methodological approach (Creswell, 2015). Because of this, I started to reflect critically on my own practices. This was not the first time that I was critically reflecting upon what I have experienced; I have critically observed and documented it in many of my earlier assignments from my earlier degree at Kathmandu University. The earlier section (Chapter IV) showed my transformation from a conventional, teacher-centric, and positivist teacher to a progressive STEAM practitioner and a transformative teacher guided by emancipatory interest. Additionally, this first phase shows my position to establish myself as a transformative researcher in STEAM education. The auto-ethnographic studies like Manandhar (2021), Shrestha (2018), and Pant (2015) oriented me towards auto-ethnographic inquiry by critically examining my practices and set my position of transformation from a highly positivist teacher to a transformative teacher/educator.

This first phase established my position and my preparedness for the second phase. On the other hand, I chose PAR as a guiding methodology which helped me to contextualize the practices I gained as a STEAM practitioner and an educator. In the participatory action research plan, I have collected and analyzed all the possible types of data to serve the aim of this research study. As a combination of various (two) qualitative methods (autoethnography and PAR), this study is participatory autoethnography (see Dhungana, 2022; Silverman & Marvasti, 2008) which is not a straightforward task (Small, 2011) rather "investigation to find the consensual and multidisciplinary definition among academia" (Reis, Amorim & Melao, 2017, p. 287). Participatory autoethnography as multi-method research is an increasingly prominent technique (Ahram, 2013) "as some scholars have become progressively aware of its benefits, through which the strengths of one method can offset the limits of another"

(Bennett, 2015, as cited in Reis, Amorim & Melao, 2017, p. 279). Such research design is based on a methodological research strategy that includes more than one method of collecting data and more than one method of analyzing the data; such methods can be based on qualitative techniques, quantitative techniques, or a mix of both (Mills et al., 2010).

To address the need and purpose of my inquiry in this study, I found participatory autoethnography design is the best fit. In this way, I was oriented towards participatory autoethnography as a multi-method design in this research study.

Research Paradigm in this Study

In this research, I have selected a participatory autoethnography research design that is informed by more than one paradigm. The paradigms determine both ways of looking at the event or situation and the research method that should be adopted to study those situations. As this research incorporates Interpretivism, Criticalism, and post-modernism; the knowledge in this study is constructed through social interactions and based on the experiences of co-researchers and the researcher himself. In this scenario, this study is guided by a multi-pragmatic genre.

I found that the paradigm is a technique of realizing and accepting the reality of the world and understanding it (Rehman & Alharthi, 2016). Likewise, the paradigm is "a basic set of beliefs that guide action" (Guba, 1990, p. 17). So, the worldviews (paradigms) are the human construction (Lincoln, Lynham, & Guba, 2018). Here, the paradigm provides me with the worldviews under which I can scrutinize my issue.

Interpretivism

In the case of Interpretivism, Luitel (2009) emphasizes that such research design is concerned with understanding and investigating the meaning of society. This paradigm helps me to understand the phenomena from the deep inside by learning to stand in the shoes of participants (Tayler & Medina, 2013). It rejects the adaption of absolute or objective truth (Guba & Linkon, 2005) and advocates for subjective reality. This shows that interpretivist researchers believe in socially constructed realities where a person should emerge own-self in the active construction process of knowledge rather than perceiving reality as a passive-receptive process (Flick, 2004). As an interpretive researcher, I believe in socially constructed multiple realities which helped me to present my lived experiences at different points of time of my academic

currier through my stories. This paradigm helped me to believe in the subjective understanding and realization of my own practices as an autoethnographic researcher.

In addition, I co-constructed the knowledge with my co-researchers feeling and their context being down to earth and having a huge interaction to unfold their realities. The epistemology of interpretivism is that knowledge is inter-subjective construction and reality is socially constructed. It helped me to build a rapport with my co-researchers, unfolding their experiences and feelings about my field study in formal and informal settings. In addition, this paradigm helps me in the interpretation and analysis of the collected data from the participants and the entire context of the research through viable interpretation using writing as an inquiry process.

Criticalism

As this study consists of participatory autoethnographic research as a methodological dimension criticalism helps me to point my finger toward myself or at my practices as an autoethnographic researcher. Moreover, this paradigm helps me to unpack the social imbalances, inequalities, and inhuman practices in our society and advocate for social justice, and enabling 'deep democracy' (Kincheloe & McLaren, 2011). As this study consists of PAR as a secondary method of inquiry which has the quality of a critical paradigm, I let my participants, including me, in a critical discussion through dialogues and dialectics (Lincoln & Guba, 1994) to challenge our existing belief system and taken for granted assumptions on our pedagogical practices and curriculum images. I encourage them (participant teachers) to critically reflect not only on the status quo which influenced their practices but to reflect critically on the practices during this research study. The critical reflections of my co-researchers, including me, has addressed by this research study. While doing this, the critical paradigm helped me to present myself as a 'change agent' (Fullan, 2012). In doing this my participants were free to raise their voices against their unjust pedagogical practices and provide me enough room to uncover their experiences during their transformation.

Postmodernism

As a transformative researcher, I believe that a single way of representation might not address all the aspects of the real case scenario, and we need multiple 'representations' (Denzin & Lincoln, 2017) to express our thoughts. To catch the real essence of knowledge we may need various means of communication ideas like language, art, gesture, etc. which fall under the Postmodern paradigm. As this study

incorporates participatory autoethnography design; it demands a multi-genre of representation of the collected information. For this, I am guided by subjective epistemology. In this study, I have used every possible way of representation like narrative genres, photographs, paintings, creative models, plays, etc. to present the meaningful knowledge gathered from the research site.

My Axiological Assumption

It is a philosophical worldview, concerning the theory of value which incorporates the terms of ethics and aesthetics. Ethics investigates the moral standards that regulate right and good in individual and communal conduct whereas aesthetics concerns the concept of beauty and harmony. 'I' as an integral part of this study in autoethnographic inquiry, my values, perceptions, experiences, and beliefs guide me in interpreting and questioning my practices. As a researcher, I valued every participant and their experiences who were part of this study. As this study incorporates two major methodologies, I believe that participatory action research in education is done to make a difference (Nixon, McTaggart, & Kemmis, 2014) in the current practices with the motto of improvement for the future. In doing this, the participants in this study were an inseparable part who guide the action, reflect, and make a difference. I valued the voice of each participant in this entire study through prolonged field engagement. Throughout this study, I was an insider of each activity being a major part. So, in this study, value is a bonding between me and my research participants. Therefore, my value influenced this research study.

My Ontological Assumption

Ontology is a kind of philosophical design that refers to the reality of being and the nature of reality (Denzin & Lincoln, 1994). This assumption believes that reality can be absolute or multiple. Absolute reality refers to the single or objective reality whereas multiple refers to the subjective one. I also believe that "reality depends upon the time and context" (Pant, 2015, p. 34). I am guided by the assumption of reality that possesses multiple truths in this study. I also believe that there is no universally accepted reality or understanding and the way of adopting and accepting any phenomena by each individual can be different from one another. This shows that there are "truths" instead of one truth.

The very first aim of this research study is to explore and critically access my pedagogical belief and practices as a learner, teacher, and educator in mathematics education. Being an autoethnographic researcher I believed that reality depends upon

time and context. Being a transformative learner, and a practitioner I believe in multiple truths i.e., subjective knowledge. My stories and episodes in this study reveal my pictures driving from a highly positivist scenario towards the transformative scenario in mathematics education. The critical lenses of my own practices show multiple versions of me; to stand on such a stage I am guided by subjective reality.

On the other hand, this study possesses a combination of qualitative approaches where both methods advocate for subjective knowledge. Throughout the process of this research study, I enhanced and motivated my research participants to search for possible alternatives to every solution to the problem. There were multiple methods/approaches to implement my plan of action, to get experience from the participants, to uncover the realities embedded in using STEAM as a pedagogical approach, to meet the realities of participants, and to represent participants' experiences and my learning in writing descriptions in this study. Hence, I had a subjective ontology in this research study.

My Epistemological Assumption

It is a philosophical concern that talks about the method of obtaining true knowledge by humankind. It is a theory of knowledge that shows this study incorporates the subjective knowledge obtained from the participants. Mingers (2003) elucidates that epistemology acknowledges the existence of various methods of comprehending the world. Here, epistemological assumptions come along with my research study. As a participatory autoethnographic researcher with participatory autoethnographic design, I believe in multiple ways of knowing. As this study incorporates two major methodologies (autoethnography and PAR); the ways of collecting the evidence are also in multiple ways. As a transformative researcher, I believe that knowledge is fallible and depends on time and context. I mean, I should understand how I understand and research the world (Cohen et al., 2018). In this context, I believe in the subjective construction of knowledge in which knowledge is embedded in the experiences of my participants. I believe that knowledge can be varied from one participant to the other and I accepted their explorations throughout this study.

The knowledge in this study is constructed with the social interaction between the researcher and co-researcher along with the context and experiences of the researcher of this study. In this scenario, my action plan promotes social constructionist epistemology with the assumption that there is no absolute truth and it

is contextual and timely. I started this study with the assumption "to establish how various claims for truth and reality become constructed in everyday life" (Easterby-Smith, Thorpe & Jackson, 2008, p. 93). In this study, the nature of knowledge is subjective and embedded in the collaborative consensus, and the production of knowledge resides at the intersection of co-researcher and researchers involved in the practice-changing practice. I have portrayed my experiences in the form of stories and episodes taking myself to different points in time in my past. In addition, I caught the scenario and experiences of PAR context through the class observations, interviews of the participant teachers, their reflections, photographs, students' interview, and so on. The assumption knowledge is situated in a human context or a person's understanding of the world of phenomena best fits with my research study.

Methodological Orientation

The methodological stance of my study is the implication of subjectivist ontology and social constructionist epistemology with the aim of change in our (me and my co-researchers) pedagogical practices and re-constructing our belief of teaching and learning through the STEAM approach. "Methodology focuses on how we gain knowledge about the world" (Denzin & Lincoln, 1994, p. 99) and identifies that different methods can guide the action in the world (Mingers, 2003). The purpose of this research study is to explore how STEAM pedagogy helps me (as a practitioner-researcher, teacher, and teacher educator) and my co-researchers (teachers) at the secondary level to improve our pedagogical and professional practices. To serve the need of the research question and the purpose of the study; this research incorporates with multi-method research design in participatory autoethnography where I incorporated my own experiences (Auto-ethnographic inquiry) in Chapter IV and participatory action research (PAR) study in Chapter V to VII. In this sense, this research design is a multi-method qualitative study in nature.

Generally, in qualitative research, we deal with human behaviors, language, and experiences. Creswell (2015) states that "Qualitative research is best suited to address a research problem in which you do not know the variables and need to explore" (p. 16). It is a systematic and subjective approach used to describe real-life experiences. It is adapted as a person-centered and all rounds to understand the human experience, without focusing on specific concepts. In qualitative research, the researcher tries to examine the experience from the participant's point of view to interpret his/her words. It develops an understanding of people's opinions.

The researcher's and the co-researchers' point of views, experiences and attributes towards the STEAM approach and its implication in secondary mathematics were the prime data for this research study. To serve the need and purpose of this study firstly I have critically reflected on my own experiences (in Chapter IV) and then dealt with the findings, observations, experiences, and all possible data which can portray the phenomenon of my action in the context of implementing STEAM pedagogy in secondary mathematics.

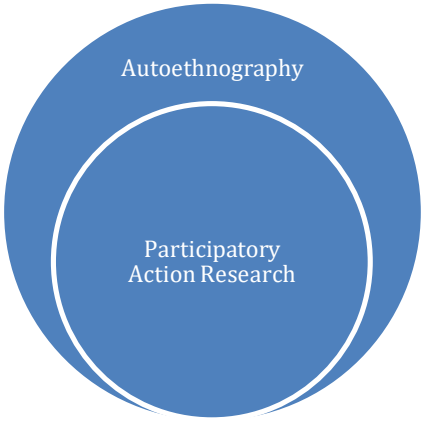
Participatory Autoethnographic Research Design as a Methodological Stance

Research design is the detailed plan of the investigation. Research design provides the researcher with a plan and direction for research. A research design is a path of the research and it can be compared to the blueprint or model of the study. A design provides a structure to the research which depends on the purpose of the research. Research designs are used to collect, analyze, and interpret data using quantitative and qualitative research (Creswell, 2012). This research study is based on the information that I have collected from my own experiences as an autoethnographic researcher and the experiences of co-researcher teachers along with my self-inquiry from the PAR context.

In this journey of writing, I am contemplating how I would give a complete shape to accomplish this study. To serve my research purposes, I found the investigation in my journey could be best-fit. For this, I have chosen autoethnographic research design and the PAR method which can contextualize the knowledge and skills which I had gained in my academic tenure.

Figure 3.1

Concept figure of multi-method study in my research



Autoethnographic Inquiry

Hello, are you listening to me?

I am here telling my stories to you all.

I am expressing myself through those words.

I want you to feel what I feel.

And I want to feel what you feel.

My words may represent you in my texts.

My text might find you somewhere in the scenario!

"Sunne lai sun ko mala, vanne lai ful ko mala"[1]

Figure 3.2

A metaphor used in folk stories

Stories are very familiar to most of us. We might be familiar with listening and reading the stories from our earlier days. I can remember my parents, telling stories after dinner, and sitting around *Aageno* (a typical place to burn a fire for the cooking purpose). Sometimes, they used to tell historical and religious stories like *Ramayana, Mahabharata, Swosthani,* and so on. And sometimes they used to tell their life experiences; what they have done; how they have done; what they could have done; and so on. We used to listen to them and used to make our own perceptions to deal with those scenarios. We used to learn the circumstances and impact from their experiences and used to feel more mature towards those phenomena. Now I realized that they were sharing their autoethnographic journey. They were reflecting critically on their own practices. We might have taken the reference of many others' experiences in our non-academic life journey.

Now as an academic person, I found autoethnography as an act of writing about oneself to explore and understand one's culture; culture is "a group-oriented concept by which self is always connected with others" (Chang, 2016, p. 13). Likewise, Ellis, Adams, and Bochner (2011) also mentioned that "autoethnography is an approach to research and writing that seeks to describe and systematically analyze personal experience to understand cultural experience" (p. 1). Further, Pithouse-Morgan et al. (2021) pointed out that "autoethnography as a complex and potentially transformative methodology for understanding and enacting higher education by

[1] *Golden garlands for the story-listeners and flower garlands for the story-teller, may this story go to the heaven*

arguing that creating and teaching autoethnography can open spaces to experience higher education as a social, ethical, and collective endeavor" (p. 215). In this study, I narrate my experiences in the form of stories, episodes, and conversations to emphasize 'me' to understand the 'others' (Ellis, 2017).

In this regard, Spry (2018) argued, "autoethnographic works often conceptualize the other to understand self" (p. 1094). This methodology helped me to critically access my own practices and made me (along with the readers) more mature in the same journey. Researchers like Shrestha (2018) wrote in his M. Phil dissertation, "auto/ethnography is the integration of autobiography describing the self-milieu and ethnography describing cultural milieu" (p. 53). Similarly, Liu (2020) stated that "the reflexive nature of autoethnography felt like a comfortable fit in my early development as a critical management scholar. I was instantly arrested by what seemed like the most sensible and natural way to write about my work" (p. 420). In this regard, I always remain aware in reflecting critically on my cultural practices in academic settings through which the readers can empathize.

Participatory Action Research

Continuing the discussion above, I was guided by the notion of Participatory Action Research (PAR) method inside autoethnographic inquiry, in this study. It can be defined as "a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purpose" (Reason & Bradbury, 2001, p. 1). This subset of action research is the "systematic collection and analysis of data to take action and change" by generating practical knowledge (Gillis & Jackson, 2002, p. 264). As a participatory action researcher, with emancipatory interest, I employed reflective and action-oriented methods as an intervention in teaching secondary mathematics.

This study begins with the practical problems of the secondary mathematics teachers working in one of the private schools in Kathmandu Valley. The participants involved in the process are co-researchers who took part in the intervention to challenge their own practices. I believe that the solution to the problem and knowledge lies at the local level/phenomena (Ozanne & Saatcioglu, 2008) which can be uncovered by PAR. In this phenomenon, the continuous and cyclic process of '*plan, act, observe, and reflection*' developed by Kemmis, McTaggart, and Nixon (2014) can be a guiding principle in this study.

While implementing PAR in the desired location school to address the practical problem of so-called conventional approaches to teaching secondary mathematics, we implemented the STEAM approach to solve the practical pedagogical issues faced by my co-researchers (participants in the field). For this, I adopted the steps of participatory action research to accomplish this study. On the other hand, action research is an inquiry that enables practitioners to examine and assess/evaluate their work (McNiff & Whitehead, 2006) to improve classroom teaching and solve practical problems relating to the classroom. It seeks the answers to the questions such as 'What am I doing?', 'How do I improve my teaching and students' learning?', 'How can students' learning be enhanced?' etc. While doing so, we (participating teachers in the field) have solved our own classroom-related problems, heightened our consciousness level, and developed our professional and personal strengths. This shows that this research is with the people (students/teachers) not on the people.

In this scenario, I collected the possible forms of data from interviews, discussions, observation, filed notes, and all other possible ways of collecting information from the field which can serve the interest of this research study.

Location and Co-researcher of My Study

We (me and my five other participants) have conducted this study in one of the private schools in Kathmandu Valley. This study is conducted with the teachers teaching in Grade X. Among the five teachers, one is from a science background and is teaching science to secondary students for more than 15 years. He has completed B. Sc. (Bachelor in Science) with a major in Biology and completed Masters in Management (MBS). Apart of a science teacher, he is a founder director and a coordinator in the same school and is engaged in teaching Bachelor's level in a few colleges around the location of this study.

The next one is a mathematics teacher who is Masters Graduate in mathematics (MA in Mathematics) from the oldest university in our country (TU). He is working in different schools in Kathmandu and teaches mathematics for Grade IX to XII students. He has more than 10 years of experience in teaching at this level. He is one of the participants in this study.

The third one is a social-studies teacher who has completed his master's degree in Sociology and completed BA LLB (Bachelor of Arts - Bachelor of Legislative Law) as an additional degree. He has more than 15 years of experience as

a social studies teacher at the secondary level. In addition, he is a founder director in the same school which makes us easier in executing our intervention plans.

Similarly, the fourth one is an English teacher having experience of 8 years in teaching English at the secondary level. He has completed his school education in New Delhi, India, and higher education from TU, Nepal. He had also worked in different places in Nepal as an English teacher and engaged in this school for 2 years.

The fifth participant teacher in this study was a young and energetic computer teacher. He has recently completed his Bachelor's degree from the affiliated college of a foreign university in Nepal. He has around 3 years of experience as a computer teacher at the secondary level. He was the youngest participant in this intervention but his computer skills and innovative ideas in this intervention have a great contribution to sharing computer skills with all other participants.

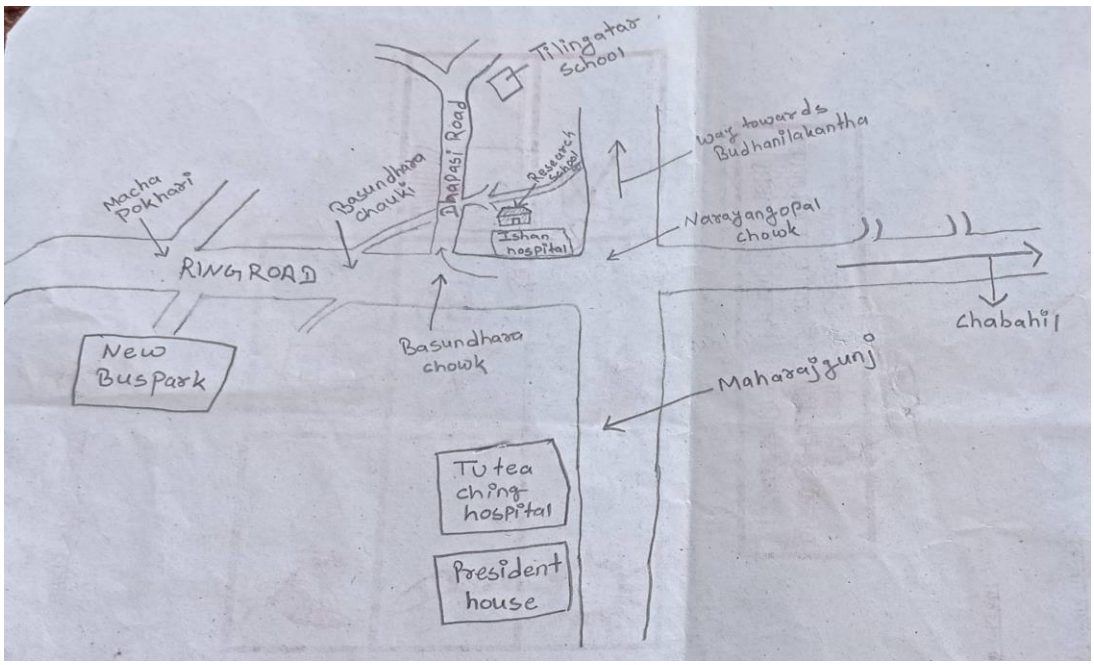
In the earlier phase of this study, we discussed multiple times in formal and informal settings. In the informal discussion with these teachers in social media (Facebook Messenger), I found that students have negative attitudes towards learning mathematics; they are good at memorization and rote learning; they have lower cognitive levels, and they are good at linguistic and logical thinking (I have already discussed it in Chapter I as problem statements or need assessment). As a preliminary plan, I was supposed to work with only 3 teachers beside me, but the scenario favored me to work with 5 teachers other than me. Two more teachers were interested to participate in the plan after the first intervention program (teachers training workshop on STEAM pedagogy). However, as per the need of the field, I kept my number of participants open to the end of this study.

In addition, this study was conducted with the teachers teaching in Grade X; the role of students and school was immense to make this study possible, so I considered the Grade X students, the school administration, and other staff in the school as secondary participants. Their reflections and experiences are also included somewhere in the discussion and analysis section in supporting the idea of primary participants. This is because the integrated plan we designed was executed in Grade X. I spent more than two-month time (from 22 April 2022 to 6 July 2022) in the PAR context for this study (see Appendix I). This duration contains the planning of STEAM projects, workshops, two cycles of project implementation, teachers' reflections, and modifications in our plans. Each cycle was of fifteen working days, and we spend thirty-five working days (22 May 2022 to 6 July 2022) for two cycles

that contained the implementation of projects and the reflection of the co-researchers. We worked in a team for this study where we continuously reflected on our plans and execution of plans that helped us to modify and reframe our actions. We reworked and amended our plans based on the student's learning and performance. Along with this, the role of the school in the enough opportunity to execute our plan was also very important. Their positive responses and motivation always provoked us to serve the need and interests of this research study.

Figure 3.3

Research Site Sketched by a Student

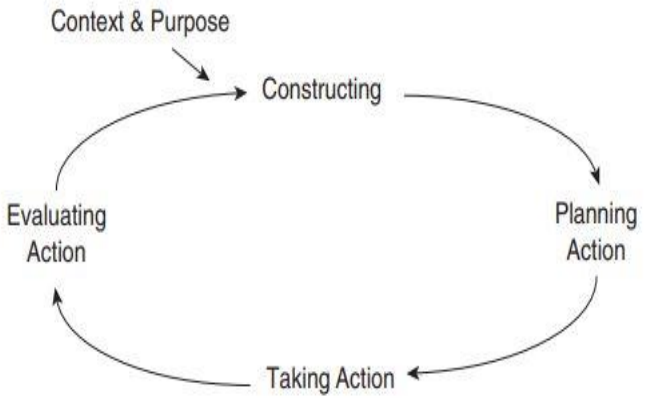


Participatory Action Research Cycle

My action research project is designed to follow the meta-cycle of action research discussed by Coghlan (2019) in his book which runs as a *construct, plan, act, and evaluate*. Likewise, this cycle is discussed in an article by Coghlan and Brannick (2014) also. Moreover, the action research cycle which consists of *plan, act, observation and reflection* developed by Kemmis, McTaggart, and Nixon (2014) also guided me in observation of the plan and taking the reflections of my co-researchers.

Figure 3.4

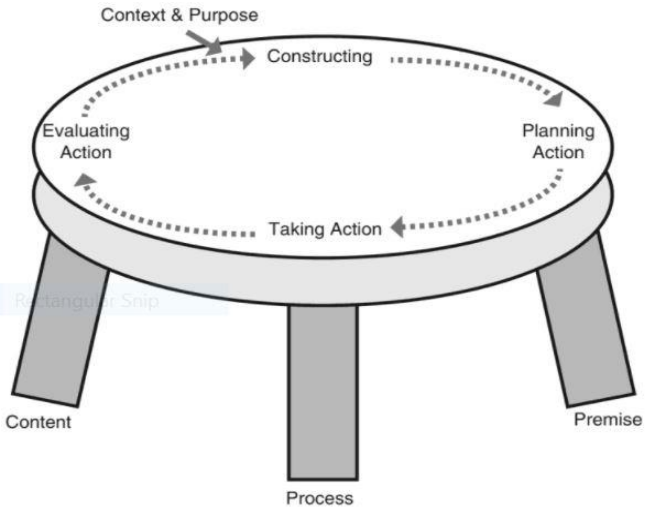
Action Research Cycle



(Coghlan & Brannick, 2010, Coghlan, 2019)

Figure 3.5

Meta-cycle of action research



(Coghlan & Brannick, 2010, Coghlan, 2019, p.14)

Constructing in this cycle cab brings together key stakeholders to form a cross-functional team within the focal organization at the outset of the project. The goal is to gather and examine the issues faced by my fellow researchers. In this process, I had a huge discussion with my co-researchers and other necessary stakeholders (like the principal) in that school.

Planning involves assessing the current stage of the co-researchers pedagogical practices and determining the need for change from the status quo – i.e. from conventional pedagogical mathematics teaching to participatory evaluation. At this stage, in solving our practical problems relating to the classroom and pedagogy, I worked as an expert and co-participant with my other colleagues (teachers) to design STEAM lessons. These lessons were designed based on the transformative curricula and pedagogical perspectives such as inquiry-based, project-based, problem-solving, and activity-based including the five components of STEAM which are connecting with Science, Technology, Engineering, Arts, and Mathematics. Accordingly, we planned, acted, observed, and reflected on these STEAM lessons/projects for implementation inside the classrooms. This cycle carries two weeks at a different point in time.

Acting is the stage for the implementation of those designed STEAM lessons in classroom teaching. We implement STEAM lessons for four weeks (Cycle 1 and Cycle 2; each cycle of 15 days as shown in Figure 3) that were designed in the planning phase. We divided these four weeks plan into two cycles for the implementation and collect the output results and critical reflections of my co-researchers after each cycle and can have the modification for the next phase when it was necessary. It is also the stage where I was dealing with the cultural dynamics and hopefully conducting an actual implementation of our pre-designed plan in the classroom setting.

Evaluating is the stage where we collected the information happening throughout the implementation of our actions through interviews, observations, and focus group discussions. “It is the climaxing stage to review the process and examine emergent questions about the intervention to see if the desired outcomes were produced” (Chukwu, 2015, p. 64). This stage was the time to see/observe and reflect on the experienced gained and the consequences and effects of the intervention. This stage is also considered the stage where we can ensure the effectiveness or evaluate whether our desired outcomes are achieved (Coghlan & Brannick, 2010) or not. The data and information were collected from the field using the three Es model for data collection techniques mentioned by Mills (2011), and they are:

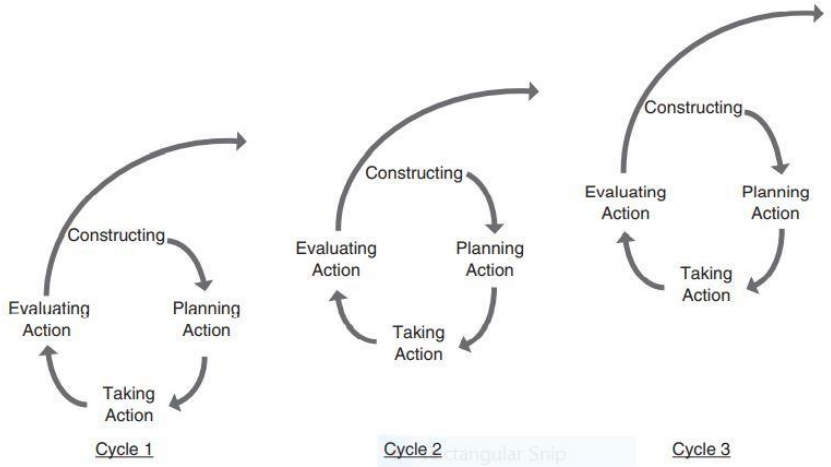
Experiencing – We collected the information and the changes that occurred in an individual's behavior and activities by observing and taking field notes.

Enquiring – While collecting data from my participants, we sat frequently for formal as well as informal discussions and took interviews with students. During this phase, we critically reflected on our practice of action implementation, ask questions to each other, and re/evaluate our work. Thus, the interaction and discussion in/formal settings were other major sources of valued data for my research study.

Examining – During the data collection process, we tried to gather the information through reflective journals, audio, and videotapes of classroom activities. Not depending on one source of information, we used several sources for collecting the data we needed. Similarly, I used the triangulation method to examine data.

Figure 3.6

Spiral of action research cycles



(Coghlan & Brannick, 2010, Coghlan, 2019)

The detailed plans and the timeline of PAR are presented in Appendix I.

How Data Was Generated and Captured?

As this study incorporates participatory autoethnography research methodology as a multi-methods research design. My own experiences are there in the first part (Chapter IV as auto-ethnography) and in the second phase the data is collected from the field of PAR through different methods like discussion, interview, observation, and so on. For the auto-ethnography part, I critically reflected on my practices and represent my experiences in different episodes. My primary source of data collection was the focus group (my co-researcher teachers), but it also includes one-to-one interviews. The focus group interview can generate insightful and useful

rich data in a short time and economize manner (Davies, 2008). But in a focus group interview I need to play the role of moderator which demands the creation of "a situation where all participants feel comfortable expressing their views and responding to the ideas of those around them, bearing in mind that the focus group interview should never be organized without structure, though it is loosely structured" (Stokes & Bergin, 2006, as cited in Easterby-Smith, Thorpe & Jackson, 2008, p. 151). For this, I designed semi-structured interview questionnaires which guided me to make the focus group interview true.

Data Analysis and Interpretation

As this study is informed by more than one paradigm, I have dealt with different forms of data like stories, interviews, reflections, pictures, and so on. During the analysis and interpretation, I presented the collected information and discussed it with the supportive literature. In doing this, I found that the focus group or my co-researchers provided me with rich data and information regarding the intervention and their experiences. The recorded data from the field, interviews, and observations were transcribed without losing their originality. Pseudo names were used instead of the participants' real names in the analysis procedures. The data is refined and used for the further process. For the analysis of gathered information, the social constructionist approach is used which is concerned with broad patterns of discourse that have used a thematic style (King, 2012). "Qualitative data analysis involves organizing, accounting for and explaining the data; in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities" (Cohen et al., 2007, p. 461). The textual data is analyzed to find codes. Gibbs (2012) defines coding as identifying themes in data with labels categorizing the data into main themes. Coding allows the researcher to identify patterns discovered in the data. These patterns of codes provide sense to the study. Further categories and groups were formed for the codes of data with similar characteristics and themes formulated to address each group. The codes are analyzed and interpreted under the themes with the supportive literature to understand the information they are reporting. The patterns are used to understand teachers' experience in adapting and implementing STEAM pedagogy in their mathematics classrooms.

Ensuring Quality Standards

The quality standard of any research is a very important aspect of any study. Bergman and Coxon (2006) argued, "quality concerns play a central role throughout

all steps of the research process in qualitative methods, from the inception of research questions and data collection to the analysis and interpretation of research findings" (p. 1). Every researcher must maintain the quality of the research study by taking the responsibility in portraying accurate and truthful production of knowledge so that the readers will get the valid and authentic information. Action researchers works as a practitioner and his/her job is to set the standards of practice and judgment (McNiff & Whitehead, 2006). As this study incorporates participatory autoethnography in its design; trustworthiness, pedagogical thoughtfulness, and praxis are taken into consideration as the quality standard.

Trustworthiness

To ensure the validity of a qualitative study, four elements must be established: credibility, transferability, dependability, and conformability (Shenton, 2004). To maintain credibility in this study, the researcher established a relationship of trust and maintained a sustained interaction with the participating teachers (co-researchers). Credibility refers to truth values that are set out to be enquired (Cohen et al., 2018). While doing so, I spent enough prolonged time collecting the data and study-related information. I spent enough time in the field until my data get saturated. I kept deep and thick descriptions of the data collected from the field.

Similarly, I as a researcher-maintained transferability in this study which is parallel to the internal validity of post-positivist research (Bryman, 2016). Transferability of research means how the research findings are useful and like others across educational settings. For this, the researcher believed that the findings of this study could be useful for other stakeholders related to a similar field. To maintain transferability, I maintained a thick description of the data and findings as thick descriptions help people connect the result to their own context (Lincoln & Guba, 1985). So, I believe that this study is helpful for other levels and contexts as well. Next, to maintain conformability I interpreted the result of this study based on the observed and collected data which is free from biases (Denzin & Lincoln, 1994). And finally, to maintain dependability, I maintained the consistency of the data and findings in this study.

Pedagogical Thoughtfulness

Pedagogical thoughtfulness is considered an application of the research findings for the purpose of teaching and learning activities for readers and researchers. It's about making teachers and teacher educators more conscious of the

deep-seated assumptions that underpin their ideas (Luitel, 2009). As a researcher or teacher educator or a teacher, the act of becoming attentive and reflective is essential in bearing education. In this regard, Van Manen (2016) stated pedagogical thoughtfulness is an act of becoming attentive to and reflective on those situations which have a direct or indirect bearing on education and pedagogy. Here the implication of the research findings is applicable in the classroom implication. We can relate this to the transferability of the study in teaching and learning settings. Doing so, I believe in the usage of STEAM pedagogy in teaching mathematics to Grade X students. Teachers moved forward or improved their teaching practices which possibly help them to come out from the conventional approach of teaching to student-centric settings. The finding is helpful for other educators to conduct similar kinds of STEAM approach research. This study might help them in making plans, preparing projects, and implementing them to improve mathematics teaching and learning. Besides the educators, this study is equally helpful for others like policy makers, curriculum developerss, and educationists to think and integrate STEAM pedagogy aligning with curriculum for transformative learning.

Praxis

Action research is concerned with the practice and intervention of plans to solve or to modify the way of doing in a better way. In my study, I followed an inductive approach of knowledge construction from the field where my co-researchers belong to. In this regard, praxis can be taken as one of the quality standards in this study. Negotiation, reciprocity, and empowerment describe research as praxis, which is a democratic method of inquiry (Lather, 1986). Thus, the Critical Emancipatory approach guides PAR, aiming to transform the practice traditions of education from within (Kemmis, 2010). In this research, I interacted and negotiated with my co-researchers for exploring the needs of the field, developing plans for pedagogical innovations, and implementing the actions in the context. We shared knowledge to serve the need of this study. I always gave space to my co-researcher to challenge his/her own frame of reference of pedagogies, which helped them to be aware of the taken-for-granted assumption. As far as PAR is concerned way towards empowerment in their professional context is assured.

Verisimilitude

The next quality standard is verisimilitude, which means the quality of seeming to be true or real. It is “a criterion for a good literary study, in which the

writing seems ‘real’ and ‘alive,’ transporting the reader directly into the world of the study” (Creswell, 2007, p. 250). In the case of “interpretations of personal realities, it is important that these studies meet the criterion of verisimilitude” (Loh, 2013, p. 9) and this study reflected the personal realities while reflecting the individual practices during the execution of the plan. Therefore, to establish verisimilitude in my study, I as the researcher presented the interpretation and findings of this study in such a way that they resonate and seem believable to the consumers of the study and produced the vicarious experience of being in a similar situation. Then only the readers can be able to understand the decisions made and the emotions felt by the participants in the study.

Critical Reflexivity

The standard of critical reflexivity in this research study entails how and why I perceive, practice, believe, and expose myself throughout the participatory autoethnographic design. Being a researcher guided by criticalism in this study I unearth my conventional belief and practices through a critical lens and make resilience to those pedagogical practices. The pedagogical shift in my professional and personal journey through the critical self-reflection also portrayed my matured picture as a STEAM practitioner through this study. I found reflexivity is “an ability to notice our responses to the world around us, people and events, and to use that knowledge to inform our actions, communications and understandings” (Etherington, 2004, p. 19). In this research study, I maintained critical reflexivity by critically reflecting upon my own practices as a learner, teacher, and teacher educator. In addition, I have critically reflected upon the deep-seated beliefs and false consciousness I gathered from my cultural settings.

Mindfulness

The word mindfulness was not a new word to me but its actual meaning and its essence in transformative research are new. Mindfulness is closely tied to the Eastern idea of “unconditioned or pure awareness,” a state of consciousness that operates objectively and with insight (Krishnamurti, 1994). I heard this word for the first time in a session of “The art of living” [a Yoga course] in 2011. I used to think that the word mindfulness simply refers to the awareness of the mind. Awareness in the sense of active participation and listening or thinking carefully. After attending a course on ‘Transformative research methodology’ in my M. Phil. In the study, my perception of mindfulness changed. It is not only limited to being aware but being

stress-free, non-judgmental, and non-reactive are some of its additional features. The researchers like Morris (2020), Singh and Spence (2016), Frank and Marken (2021), and Langer et al. (2020), etc. have also argued about mindfulness.

The session with Dr. Wagle (course facilitator) gives light on mindfulness where I got to know some major vocabulary such as non-judging, patience, beginner's mind, trust, acceptance, letting go, non-striving, etc. as a pillar. These vocabularies support me to widen my perceptions of mindfulness. After this session, I understand that mindfulness can be a way of living for us. Its notion of 'being present and 'looking at the phenomena without a frame of reference promotes equal-mindedness in one's perception and develops a holistic mindset (Shapiro, 2009). Such a mindset can promote equity in society and develop a person in such a way who can see all others with equal height just as a human. Such a mindful mind is a mind that is more open to learning and development, rather than finding the right or perfect solution.

In this research study, I used mindful observation as a quality standard. In conducting fieldwork in this study and collecting the data from the context I will be mindful enough to extract the actual reality and the effect of my plan. The non-dualistic worldview of mindfulness also proposes that ontological truth, in which the person and the phenomenon under investigation are parts of the same reality, emerges from the experience of ontological oneness (Singh & Sence, 2016). My research study also believes in and promotes subjective reality which holds the notion of mindfulness. I am working with five participant teachers as a co-researcher where I found two of them as token participants who rarely participate in the plan but the remaining three actively participated. In this context as a mindful researcher, I have tried to minimize my influence and frame of reference in collecting the data and observations. Though we worked together in designing the STEAM projects, my prior understanding did not judge their potentiality while collecting their reflections. Mindfulness is a deliberate examination of the impact of context and expectations on practitioners, as well as the potential risks, drawbacks, and limitations of the practice (Davidson & Kaszniak, 2015). Additionally, there is a growing effort to expand the methodologies employed in exploring mindfulness practices (Frank & Marken, 2021). I kept patient and observed the phenomena like a beginner's mind. I accepted any kind of result from the context and interpreted it as it is in my study. The notion of letting go guided me to accept any kind of situation in this phase.

The context of transformative learning theory (Mezirow, 1991) comes up with the questions like what is the way that I can pursue so that I can change myself and my entire society for the betterment. And most importantly, what is that thing that I can work with to heighten my and others' consciousness? The theoretical perspective of this theory lies in communicative learning rather than instrumental worldview where we can make sense of our experiences with the world from subjective judgments. In this context, every learner should be reflective critically on the deep-seated and long-rooted underlying beliefs, values, intentions, and attributes (Mezirow, 1997, as cited in Pant, 2017). In this scenario, mindfulness can show the awareness of the mindset with the phenomena and can critically analyze it. The stillness in mind and dharma looked at the phenomena with even-mindedness as a mindful researcher can reflect the actual subjective reality in society. Here, critical reflection matters in raising questions against existing dominant schema and set of beliefs and always seek for better alternatives.

Mindfulness research based on grounded theory and other critical approaches can play a crucial role in uncovering contextual factors, adverse impacts, and obstacles to the implementation of mindfulness practices (Frank et al., 2019). In this context, mindful researcher always tries to improve their own set of practices by critically reflecting on his/her deep-rooted false consciousness about the context, nature system, and set of beliefs. The narcissist perspective of the researcher can be challenged through the consciousness in mindfulness which can separate a transformative researcher from dualities energy vampires. The subjective mindset, belief in aesthetic values, and non-judgmental are some key features of mindfulness that can shape the future of transformative education and research. In addition, my above arguments put a significant contribution to shaping this transformative research through mindfulness as a quality standard.

Ethical Considerations

To uphold ethical standards in research, certain protocols must be followed, such as respecting participants, obtaining informed consent, preserving the privacy of each participant, and using appropriate language. Ethics means “a set of principles that embody or exemplify what is good or right or allow us to identify what is bad or wrong” (Hammersley & Trainou, 2012, p. 16). Likewise, "ethical issues may stem from the kind of problems investigated by social scientists and the methods they use

to obtain valid and reliable data" (Cohen et al., 2007, p. 51). In designing this research study, I respect and give value to all the participants and their experiences.

Similarly, I valued and respected all the people who were directly or indirectly linked with this study. I explained the objectives and the purpose of my study before immerging my co-research in this study. I was very conscious and respectful regarding my research participants in terms of their privacy, confidentiality, and professional ethics. In addition, I maintained *Dharma, Karma, and Ahimsa* as argued by Dahal (2022) to maintain the ethical conduct in this study. In this study, *Dharma* refers to duty, *Karma* to Action, and *Ahimsa* to non-maleficence. In this regard, I used *Dharma* as a symbol of the ontological responsibilities of the researcher, *Karma* as an epistemological action, and *Ahimsa* as ethics of care and altruism (Dahal, 2022; Varghese et al., 2017; Wagle, 2021). Likewise, I used the collected data and information of the respondent only for the study purpose. “Dharma and Karma in South Asia can be the organizing principles for autoethnographers. These guidelines make it possible for autoethnographers to be knowledgeable of their procedural ethics as Dharma and situational ethics as Karma in-depth” (Dahal & Luitel, 2022, p. 2678).

Likewise, none of the participants were forced or harmed physically or emotionally to be part of this study which refers to the notion of *Ahimsa*. They were free to expose their views. Pseudo-names are used in transcribing and interpreting their responses. I showed my honesty in the citation of the previous work to avoid plagiarism. I took permission from research participants to record their responses. I respect their culture, community, and social practice from the depth of my heart. People from different backgrounds were treated equally. I maintained the emerging issues of privacy, anonymity, and confidentiality during this research (MacDonald, 2012). In addition, participatory action research allows researchers to be open during the field of study (Kemmis, McTaggart, & Nixon, 2014). For this, I shared all the plans, information, and evidence inside out with my co-researchers so that we were free to make changes accordingly and build mutual relations. Finally, I assured the confidentiality of research participants throughout the research process.

Chapter Summary

In this chapter, I discussed how I conduct this study and how I interpret the collected data from the field. In addition, this chapter contains my philosophical concerns and ethical issues. I have even maintained the quality standard of this study through the components like trustworthiness, pedagogical thoughtfulness, praxis,

mindfulness, and critical reflexivity. The main idea that I incorporated in this study might be the blended approach of autoethnography and PAR. The terminology: participatory autoethnographic inquiry was generated to address the purpose of this study, where I started to reflect critically upon my own practices as an autoethnographic inquirer, and later I worked with five teachers (apart from me) for the participatory action research. In doing this, the methodological frame directed me to the STEAM implementation in our context.

As I set the roadmap of my study in Chapter III, further chapters will deal with the collected data and discussion procedures. Chapter IV contains the stories from my past experiences that can make you aware of the practices of a common learner/teacher in the Nepali context.

CHAPTER IV
POTENTIALLY A TRANSFORMATIVE SHIFT: FROM CONVENTIONALITY TO STEAM ACTIVIST

Chapter Overview

In this chapter, I share some of the memorable moments of my academic journey that reflect my transformation from the conventional model of learner/teacher to STEAM learner/teacher/researcher. I have articulated this chapter to set my position as a transformative STEAM practitioner. This chapter has answered the first research question, i.e. in what ways did my academic experiences develop me as a potential transformative learner, teacher, and educator? This chapter reflects my identity at a different level of my academic journey and a frame of reference for the PAR study. In addition, this chapter has answered some sub-questions like, where was I? What have I done? Where am I? And what am I planning for? The answers to those questions reflect my academic discourse.

Digging deep into my academic journey as a student from a community school, which was well known for its academic excellence. I joined that school in the seventh standard; before that, I had been in a Nepali medium private school. I shifted to a community school due to the Maoist insurgency in our country. All the private schools were closed that year in our district and all the school-level students were placed in community schools. The school where I was placed was more like a family school, our community school, and the school for most of the people dwelling in the eastern part of Nepal. It was the oldest school carrying many academic and societal legacies. I remember some of our teachers used to say; *tero bauko naam k ho?* (What is your father's name?), *ta falana ko xora haina?* (Aren't you the son of that person?). I used to reply "… *ho sir*" (Yes sir). Similarly, *tero baulai ni maile yesari nai padako ho* (I had similarly taught your father), *tero baulai voli school ma liyara aija* (Bring your father to school tomorrow). Such questions and statements from our teachers created enough fear to keep us quiet in school. The old teachers' presence and work service were cultured in such a way that our parents used to remain silent in front of them. I had funny, painful, silly, and proud experiences which I gathered from that community school. The subheading "schooling in a tea garden and alpine forest" down here reflects my memorable learning experiences in this school.

Schooling in a Tea Garden and Alpine Forest

Residing on the hills, I experienced very mesmerizing early school days. Karfok Vidya Mandir, was one of the prestigious and well-known government schools in the locality where I studied. The school was spacious surrounded by a big Alpine Forest, cardamom garden, and walnut trees in more than 500 Ropanis (63 acres) of land. The naturally peaceful locality with the garden full of different local flowers always dragged the attention of whoever passed nearby, however, the signboard of (DO NOT TOUCH THE FLOWERS) which was never followed consists of many bad and good memories. Good memories of spending joyful moments, eating, playing, and even sleeping on the grass. Bad memories were getting punished in the same garden now turned out to be nostalgic.

Figure 4.1

The school where I studied Grade VII: Karfok Vidya Mandir

It was the time of 2005 AD. Nowadays I stay in a city far from my hometown, rarely seeing the school where I studied. I once got a chance to visit my school after many years. My tiny little school had turned into 3 storied single buildings. Previously demolished tiny buildings hold large memories of me being one of the notorious students among 200 students in Grade VII where I studied. Students in my classroom were divided into two sections. Although being mischievous, and gifted in studies helped me to be in section A, the students with so-called poor academic grades were in section B. My roll number was 32.

One day, my class teacher punished me, the reason behind the punishment was not able to give attention to the roll call. Probably I was thinking about the Math homework which I was supposed to submit in the next period. Whenever I sat on the couch and recall my childhood, and adulthood days at school, I feel like I am watching a movie. I laughed on my own, we used to be involved in many mischievous activities like bunking the class, singing during class, and taking naps in the middle of the class. The funniest was eating "bhuteko makai" (Popcorn) as if no one was noticing. It was easy for us to bunk the class because of the large number of students'

number almost 113 students in section A and the teacher only listened and cared about front benchers or the ones who were sincere in their studies.

I was in a group of students who are always troublesome and not very sincere towards their studies and usually, teachers had tagged us "Back Benchers", whatever the tag was, I feel myself luckiest because I understand the math concept easily compared to my friends. I don't blame my teachers who only focused on the front ten benches. The classroom set-up was not favorable to study, from the back you couldn't hear and write-ups on the board were barely visible. We only used to be attentive in mathematics class, mostly our group and other students skipped and bunk other classes but no one dared to bunk math class, comparatively in the math period there used to be more students as we all perceived math was something interesting but a very difficult subject.

I was an enigmatic student, and the way I prepared myself for school never communicated I was getting ready for school, I wore a school uniform with no bags or tiffin, just a copy and a pen hanging in the back pocket of my pant. I never desired to be an honest student in the classroom. I was not so fond of following rules and carrying everything including a school bag, pencil box, tiffin box, and all. I normally walked to school without any books, a single copy and a pen were something I carried every day, walk around the school premises proudly thinking myself the coolest student. I wrote Nepali, English, and Mathematics, Social everything in a single copy, the interesting fact was that I hardly attended Nepali, Social studies, Health, Environment, and Population classes. It was the note copy of rarely two or three periods I attended in a day. Most of the time I missed every period either by bunking or sleeping or not paying attention in the classroom. I only used to stay attentive in mathematics class. The reason is nothing but my interest in mathematical studies. The reason behind liking mathematics during class 7 could be the nature of the teacher's assignment. I still feel amazed, we had very less homework.

The math teacher was the favorite of all due to her tendency to give less homework, she had a different approach to teaching, and there was no doubt we liked her because being the mathematics teacher she never bombarded us with theorem and let us recall formulas, besides that she was a good problem solver adopting conventional strategies in her teaching which is common now but was quite rare and attractive back then. Although she was a good teacher, she missed the inclusiveness of every student in her class. Inclusiveness in terms of engaging all the students in her

class activities. She only entertained frontline students and paid high attention to them, and I was a backbencher due to my height. Despite being on the back bench, I was always actively involved in solving problems, I took the initiative to ask a question and solve it, sometimes I solved the problem in the beginning and got excited to show her, perhaps that was the only reason for me to coming to the school every day. The majority of my friends bunked the mathematics class, but I never skipped any, I was tagged as "Dhokewaj Sathi" (Betrayal friend) because I always participated in making plans to bunk but never skipped a single period of mathematics subjects, and many times I was being blamed for being detached from the group and not obeying my friends. No one believes the story of me having a different personality during one particular period. In that period my whole personality was studious and highly focused for forty-five minutes, as a result, I scored more in mathematics compared to other subjects and sometimes obtained the highest in the classroom.

During those days, I remember only 2/3 percent of the students used to pass SLC exams out of 100 plus in grade 10. From my point of view, during that period, the reason behind low pass-out rates could be the huge number of students in a single classroom, how can teachers focus on the entire classroom, check homework or keep track of their performance level in the group of 100 students. Another reason could be the less responsible teachers or unmanaged schooling, there was a space or teacher could have used different approaches to engage all students, and School management could split the class, as a consequence, mostly the scenario of mathematics learning seemed pathetic in those days.

Passing through multiple examinations in different levels, SLC board, +2, Bachelor, Masters. I gradually started thinking about the possibilities of effective classes back then. If I look from the present perspective, after gaining knowledge, being aware of teaching practices, and having fine experience, the mathematics classes would be much better and more interesting if our teachers would have put in some extra effort. My school, a government school, had a huge number of resources and was well known for being the oldest and having high pass-out rates in SLC, though the pass-out rate was low compared to other schools in the same district it was high. The resources that the school was getting could be integrated into regular classrooms to have more practical and hands-on classes. We never thought of this in our school days but analyzing it now, what a pity despite being physically complete

and equipped with resources our school was incomplete. It had a massive ground, natural resources, donated sports items, teaching aids, and many more. The area of the ground could be part of studies, the temple inside the school territory, the cardamom garden, fields for agriculture, and the tea garden could be part of students' educational journey.

I think back then, our creativity was sabotaged by some misconceptions, and myths about education, especially for mathematics, we thought that it is a complicated subject focused more on memorization, rote learning, and solving problems without knowing the actual concept. Our teacher never relates mathematical calculation to our real life, on the contrary, it is connected everywhere. We never thought of this back then I wish I could time travel and ask questions to my teachers, why they didn't think about alternative pedagogical practices, I'm questioning myself now, why I never ask for the alternative. Why is the school not able to see the teaching and learning practices from different lenses? Was it the passiveness of the teachers, the carelessness of the students, or the stereotypes of society obstructing mathematical studies? Why mathematics was like pressure and a burden to students even today? Why the students were less interested in mathematics classes? Why were the students of Jha sir (mathematics teacher at the secondary level also known for B. Sc. sir), and Thapa maam (one of my favorite teachers back then) never abled to relate the mathematical concept to everyday life?

Compiling my journey from student life to teacher and teacher educator, at this moment, I see many possibilities of teaching and learning in the same context but the scenario of the time back then might be different compared to the present. My school and this context might be a good example among numerous schools in today's time as well. I found that the teachers and the school in my context either in a rural area or in town both are less aware of the assets they had which can be linked up in the teaching and learning process. From my personal experience, I have found that linking classroom content to real-life scenarios stimulates learners to explore and inquire more.

Wasn't I including my friend who would be more alert and attentive if our teacher asked or started algebra with an explanation area or plot in our surroundings? While teaching geometry, why did my teacher never relate it with the artistic shape of temples or Dhunge Dhara (Stone spout tap) in our school premises? Why were the statistics never used to estimate the average wages of labor in the tea garden, their

age, saving, and the company's profit and loss? School being in the hub of the Tea Garden, never used mathematics to solve complex and real-world problems. And we were detached, unlinked from the content and context knowledge. The contextualization of any content area motivates the learners to know, understand, and appreciate cultural heritage (Bringas, 2014). We just witnessed and be aware of our surroundings, however, we can inspire learners to look at and study their surroundings too. "Teaching students through concrete things before moving to abstraction leads them gradually from actual objects through symbols" (Reyes, et al., 2019, p. 2). They further shared that students' exposure to local materials, and local context creates a better understanding of content knowledge as well as helps make classrooms livelier where they construct knowledge. Though the scenario of my school having enough resources. They were just reproducing the knowledge from teachers to students. As a learner and a teacher of mathematics education, I discovered that the majority of the learners found it disengaged where contextualization of its concepts might give the real essence to them. Students often have difficulty solving computational problems solely focused on algorithmic solutions, without any real-world connections (Khiat, 2010; Puri, Cornick, & Guy, 2014). "To contextualize means to adopt the present environment, setting, and situation modification to achieve equity of learning suited for all kinds of learners to relate their understandings in the real context of their life" (Reyes, et al., 2019, p. 3). Such a type of contextualization in our schools may develop the learners to get ready for similar kinds of problems in real life. The technology and its exposure certainly help students to have deeper contextual and content knowledge about particular concepts too. The idea of using tools that students learned inside the classroom can be used at the right time and this emphasizes the relevance of incorporating context into the content knowledge.

As a transformative learner and a researcher believing in the Habermasian interest, I always advocate for a transformative shift in teaching and learning practices guided from the practical interest towards the emancipatory interest. I believe that the learning of any learner should not be detached from his/her context and need to empower them to be responsible for their future need.

The Poor Mathematics: Got Stuck Within the Four Walls

Teachers' job is just to teach regardless of the targeted group's level of knowledge acquisition and provide continuous support to achieve the academic goal. The prevalent pedagogy where the teaching mechanism is practiced ignoring the

students' existence leads learners nowhere on the planet. The pedagogy where mathematics itself resembled a poor subject has nothing to do with the content and the context while teaching during the classes. '*Absolute philosophies*' has tried to reflect the learning and teaching method which gets stuck in four walls.

Absolutist Philosophies

The mathematics teacher was presenting mathematics as a collection of facts that could be memorized without any questions about the meanings and concept clarity. When I came to know about the absolute view (Ernest, 1991) of mathematics which consists of certain and unchangeable truths. Creative mathematical work is neither the teachers' choice nor only of the students, requiring rigorous thinking and supporting one another (Lerman, 1990). The grounds for claiming that mathematics provides certain knowledge is the basic statement used as proof which is taken to be true. Mathematical axioms are assumed to be true, to develop that system under consideration, mathematical definitions are true by fact. This absolutist view of mathematical knowledge is based on two types of assumptions: those of mathematics, concerning the assumption of axioms and definitions, and those of logic concerning the assumption of axioms, rules of inference, and formal language.

To connect this view in my student participants of grade 8 where I went after the observation class on March 3, 2019. We had a very effective discussion though students took time to open up. One of the students started by asking.....actually on the top of the question paper, it is written that students are encouraged to answer in their own language but in mathematics, we can't answer the questions the way we want. Each day, the teacher comes into the class and creates fear by saying that we are appearing in the Basic level Examination. So, we need to be alert about the patterns of writing especially in the case of mathematics. Next student shares: when we gave the paper in the class after our examination, we found the mathematics teacher frequently encouraging us by saying it is not the wrong process and a wrong answer, you have tried to do all and ends up with.... but.... we have to think how our papers are checked. Another student added stating that if it was not the objective of the government to educate teachers at the same time, they expect us to be more creative, why are we taught some rigid and stagnant processes and concepts?

I was amazed to hear all those questions and statements from the students. That symbolized that they were worried about their examination for grade 8, unknowingly they were worried because of the absolute philosophies and their

implementation in mathematics. Reflecting self, I remember, I had deducted the marks of the students because of the answer patterns, figures missing in the mensuration question, rough sketches missing in the geometry portion, skipping the steps in mathematical problems keeping a doubt that they might have copied it, and many more. I can't change the whole system but can make myself aware of such practices and bring a small change. As our only objective is the transmission of knowledge...so far when it is transmitted, it can be interpreted the way our students want it to be done.

From the perspective of a transformative researcher and an educator, a teacher needs to be aware enough of the absolutistic and fallibilist nature of mathematics. The abstract nature of mathematics on its own and our objective pedagogical practices in the school curriculum have a narrow scope for innovative and progressive pedagogies which results in less motivation and poor performance of the students. I found mathematics teachers consider contextualization to be a more difficult and time-consuming task and disliked it (Reinke & Casto, 2020). The studies like Bottge and Cho (2013); Perin (2011); Young, Hodge, Edwards, and Leising (2012) found the impact of using contextualization in the teaching and learning process for mathematics. Those reviews and literature motivated our PAR team to contextualize the idea and concepts that students were intend to learn. Our presumption of limiting teaching and learning within the four walls restricted students' knowledge hence they have become passive followers.

2+2 makes four,
Which is very true
The content, abstract ideas written in a book
Just to be a clue,
Can Mathematics be subjective?
I doubted and started analyzing everything small
Looking into a few considerations of human nature, values, and culture
It's a tool, which needs to go beyond the four walls

The above poem also advocates that our learners are already struggling with bridging the gap between a book's mathematical concept and a real-life implication, the abstract nature and absolutist view towards mathematical education need to be deconstructed by going beyond the four walls.

Offering "*Prasad*" to Students: Priest Pedagogy

Teachers in the classroom generally have multiple ways of presenting and demonstrating their ideas in class. Based on the way or approach of the presentation the productivity and outcome of students' learning are reflected. Teachers often implement different approaches in their teaching with their comfortability, perception, experience, knowledge, skills, and the advancement in their thoughts. Some of the teachers believe in teaching the way they were taught whereas others think that they cannot teach 21st-century learners with 20th-century style.

Priest Pedagogy

Priest pedagogy presumes the teacher in the form of a priest. The knowledge given by the teacher remains as holy as *Prasad* (holy food). Students need to remain all time ready for the *prasad* distributed by the teacher in the form of knowledge in the class. In this pedagogy, teachers' knowledge is the ultimate truth where the student remains a silent receiver. Students don't present any kinds of critical opinions and thoughts over the ideas presented by the teacher. The ultimate powerful knowledge depicter of the classroom is a teacher under this pedagogy. This is like a one-way path and is compared with pipe pedagogy or waiter pedagogy.

Celebrations at School

These days we are celebrating numerous festivals in school the reasons behind the celebration could be preserving the culture and tradition of our country. The school where I was teaching was planning to celebrate '*Saraswoti Puja'* (Worshiping Goddess of Wisdom). The preparation for that day often starts one or two weeks earlier (almost every year). The task was divided among teaching, non-teaching staff, and students at school. Teachers teaching at different levels were found engaged with their respective job responsibility, they were running here and there, cutting–pasting colorful papers, preparing meals, and cleaning copper utensils at different school places, everybody was looking for perfection in the program. Students of senior grades were found involved in the preparation of self in drama, anchoring, poem recitation, dancing, singing Saraswoti Bandana, the importance of wisdom, and so on. It was considered a very important day for young learners to start school according to Hindu mythology. The school leaders were excited in between to collect new students and get busy with their admission procedure.

I was also assigned a task to help '*Pujari Jee* '(Priest), probably it was due to my Brahmin background. I could see some of my students preparing dance to glorify

the goddess of wisdom wearing traditional dress, others were preparing for *Saraswoti bandana,* and a few were rehearsing dance during bandana. In school every year, Saraswoti puja was done by calling *pujari* on the school premises of our school. Pujari (priest in Hindu culture) was called, and a puja was started, I noticed something during the puja, the regular Saraswoti Bandana was mispronounced by Pujari, some of the lines were not even spoken, the entire school was following the Pujari jee, I got my first click there, our students depend upon us for their learning, they do not critique or argue. They just follow what we say to them. We consider it as a form of respect for our learners.

सरस्वती मया दृष्टा वीणापुस्तकधारिणी
हंसवाहनसंयुक्ता विद्यादानं करोतु मे
प्रथमं भारती नाम द्वितीयञ्च सरस्वती
तृतीयं शारदा देवी चतुर्थ हंसवाहिनी

...

[*Translation: "May the goddess Saraswati, who is draped in white, holding a book and a Vina (a musical instrument), and mounted on a white swan, bless me. May she, the goddess of knowledge, bestow upon me the boon of knowledge. She is the first among the great goddesses of Bharat (India) and is also known as Saraswati. The third goddess, after Saraswati and Laxmi, is Sharda, and she is also depicted as riding a white swan.*"]

With the formal beginning of the program, students were participating actively. Some students were involved in assisting people with worshipping and managing the line of visitors. Some were busy distributing prasad and the remaining were busy performing. There were some students even volunteering and enjoying the program. All the students and teachers including the school team were involved completely in the program. It was a complete reflection of the proper engagement of the school members in the program. Some parents were even visiting for '*Akshyarambha*'[2] of small children by admitting them to the school. The account section looked like a fish market, parents were bargaining in the reception for the admission fees and monthly fees. Some of the parents were shouting and demanding white Chalk and slates instead of whiteboards and markers for *Akshyarambha*.

[2] First writing ceremony for a young baby

The involvement and contribution of the students, teachers, administration, and parents were very active during the whole process. Now, when I recall the moment of such celebration, I realized that it was a 'Priest Pedagogy' as no student was found asking questions and objecting to the process of celebration. Not even at that time when the priest mispronounced Saraswoti Bandana and skipped a few lines. All were quite engaged in enjoying the program and carrying out the celebration process more significantly. The next day when I asked my students to say something about Goddess Saraswoti, it seemed all the hard work went in vain. They had not understood the objective of the celebration. They had just taken it as an opportunity to dance, sing and dramatize the event. They could not respond to why we celebrated Saraswoti puja, and neither they were aware of its significance. They just memorized and did tasks exactly how they were assigned. This is one of the school events, and most of the time during other class activities and events as well, I rarely see someone raising questions to the teacher. Our students don't dare to ask why they should perform or participate in such programs. Neither other teaching faculties seem to be bothered about it.

The priest pedagogy can come out from its shell and flourish critical thinking amongst learners. Its connection to spirituality can add more beauty and open doors to many learning opportunities for our learners. I found the word spirituality in much more mature than my understanding and mature from all the religious practices. In addition, I got that spirituality starts where the values of religion end. It critically reflects on the religious and so-called spiritual practices. In this regard, Vogel (2000) recognized spirituality as being "drawn to visions of justice, compassion, righteousness, and peace…embracing more than the material and mundane, or the here and now" (p. 18). Further, according to Tisdell (2008), spirituality is a crucial aspect of one's life journey that contributes to the attainment of completeness. This definition of spirituality advocates for the holistic learning and development of a learner. But as a Nepali STEM learner, I found a compartmentalized knowledge in our educational practices is highly prioritized. Though CDC (Curriculum Development Center) Nepal has introduced an integrated curriculum at a lower basic level, even an updated curriculum, still the pedagogical approach remains the same as it was before. I found the majority of the teachers are guided by the traditional lecture-based approach where the teacher is the only source of knowledge and even if he commits any mistakes, his/her mistakes should not be critiqued. I have huge

experience learning as a passive learner, listening to the teacher, taking notes, memorizing the text for the examination, writing in examinations for the Grades/marks, and forgetting everything after the examinations. The interrelation between various aspects of knowledge, disciplines, and knowing is missing from our educational practices. These educational practices promote behaviorism and limit humans from holistic development.

As a transformative learner, I came to know that we can do a gradual shift of Priest pedagogy towards spirituality, this begins when an individual goes beyond his/her cultural practices in a more mature way. Spirituality begins when someone starts to reflect critically on their own experience and complexities of living in the world and starts to seek the common good and justice for all with mindfulness. Spirituality is an indispensable part of adult development by providing meaning and coherence to life's journey (Mulqueen & Elias, 2000). But the priest pedagogy creates very less or no opportunity and space for the learners to question the knowledge they gained from their teachers. There are less/no rooms for the learners to become critical or create doubts about what the teacher delivers.

Moment of Silence

Trrrrrrrrr……. the bell rang, I was sitting in the staff room and I slowly approached class 7, it was any day in 2012 AD, the class was after the tiffin break, and I could see, some of the students still playing and eating their tiffin on my way, suddenly after seeing me, everyone started running, all were frightened out of their wits. Students were running toward their class and trying to hide from my presence. I noticed some of my students were taking a U-turn after catching my glimpse. It was the everyday scenario, but that day was quite different. One parent had complained about me, I used to be a very strict teacher, holding a stick in hand was like carrying the Bible for a priest. I was so concerned regarding students' discipline and so-called proper behavior. The parent requested me to be gentle with their child, I was thinking about this particular parent's complaint during the tiffin break, and I was told to be strict and harsh as I was a math teacher. And I was following the same as what I was asked to. I was thinking about his concern. I entered class 8, the class environment was so calm, and there was pin-drop silence, although 35 students were there in one class, no one dared to move or make noise.

I continued my arithmetic chapter from the previous day's class in a regular style, I gave them classwork activities, I was teaching them basic arithmetic ideas,

and I was proud and happy to see the classroom environment. I thought that in my class students were well-disciplined. Forget all the parent's complaints and smiled internally, Haa Haa, in Bhatta sir's Period (Nepali teacher) students were making noise and it was hard for him to deliver the content. In my class, students are well-disciplined and they do whatever I asked them to do. Wow, I am the best teacher in this school. No matter what parents request, Principal Sir always encourages a silent and well-disciplined environment inside the school.

SPLASHHHH!!!

A big Bang in the classroom suddenly broke the peaceful and calm environment, Namita (student) dropped her geometry box, in those days it was mandatory to carry a geometry box. I stared at her, and she was shivering, she was sweating and asking me to forgive her. I was surprised why was she so scared? Her tears rolled down her cheeks. I remembered the parents complain this morning to be soft with the student. I did not take the complaint seriously, however, after watching Namita getting petrified I questioned myself. Am I being so harsh to my students? What made her sweat and shiver? I didn't respond and continue my delivery of arithmetic; she did not show the courage to pick up her box from the floor. I was just writing the formula on the board and students were copying from the board. At last, I again explained how the formula had been formulated and its applicability to the given problem. I asked the entire class, "Hey, have you all understood what I had just taught? Everyone noded their head and replied, "bujhyo sir (yes sir)". I was suspicious and asked questions regarding arithmetic (what I was teaching) to one student who needed support. He was scared and couldn't explain well, I was mad and shouted if you haven't understood the concept, why did you say that you understood earlier? Then I asked another student to tell me what he had understood from that class. He was also unable to answer, then I asked the entire class; only 2 students from the class understood the concept.

I was very angry with the students and repeated everything once again but I didn't ask the same questions as before and solved a problem on the board. I let them copy the solution from the board and assigned them to solve similar kinds of problems. All the students were trying to solve the problems in their own effort without any discussion, I had set a norm inside my class, and talking with each other was like a crime. I evaluated at this moment; I was an autocratic dictator who never wished or desired to hear from students in any classes in those days. I told them to

complete the assigned task in any context as a home assignment. The bell rang and I stepped out of the class.

The scenario was not of a single class, a single day, or a single year, but I was reproducing the same way of pedagogical aspect for about 6/7 years. I was not so socialized with students; my nature and behavior were cold for them. I was grown up and was mentored to be strict inside the classroom. After moving to Kathmandu, taking in-school training, observing my colleague's classroom teaching, and especially when I joint a newly approached University, I started reflecting on my own practices. I was in deep thought, about why students were not expressing themselves: what were they feeling? Why were they so scared to ask me a question or raise their voice when they have not understood the concept clearly? Am I not teaching properly? Was the stick in my hand abandoning my students to ask questions and express their curiosity? Too many questions were raised at the same time. I again recalled my math teacher who was rude and strict. Am I reproducing his nature with my students? I was reflecting on my teaching, it was more than 5/6 years since I started my teaching career, I might not have gotten enough effective training to teach mathematics progressively and just tried to teach students in the same manner as I was taught. Yes, I was mentored and guided in school in-house training, but it never focused on teaching pedagogy; instead, content matters were at the center. Over a period of time, I was not satisfied with the classroom performance of my students. I was in a great thinking process.

When I joined Kathmandu University for the first time as a Master's student, I experienced and witnessed a different learning environment inside the university. I saw the preparation of teachers before the classroom, I still remember, on the second day of our master's course, one teacher came with photocopies, it was a teaching material, holding different articles entered the class; divided us into different groups; encouraged us the discussion; and finally, we had to present what we had learned from those articles in front of the class. I have experienced collaborative teaching and learning practices for the first time in university practice in my entire academic carrier. In this journey as an M. Ed. Scholar in mathematics education, I started reflecting critically on my practices in my assignments. This critical reflection and different pedagogical practices in university made me aware of what I was doing as a teacher.

Most of the time, the student-centric approach brought positive changes in our student's life instead of the teacher-centric classroom, however, our knowledge, and skills made student orient setup difficult. For example, the implementation of collaborative practices inside the classrooms often comes with challenges (Wise & Schwarz, 2017). The natural setting for enacting collaboration is the small group. Guidance which is adaptive to the needs of the learners is necessary for collaboration to occur (Rummel, Walker, & Aleven, 2016). Arranging the class into multiple small groups turns the role of the teacher, in the adaptive guidance of coordination of actions to be very complex (Dillenbourg, 2013). I experienced that a small group of students is necessary to foster mathematical reasoning skills through collaboration. This is a great way to create a good bond between a teacher and student, formal/informal conversation with students, continuously mentoring them, and guiding them to encourage students to come forward. I call it healthy noise from the group discussion and peer sharing which contribute to fostering students' cognitive, and emotional well-being. However, we have our own limitations, creating an environment to raise their voices and to make the classroom more collaborative needs skilled and resourceful people. What I learned during this period, students should provide enough space to share their ideas and support them with reasons, discuss different views, and resolve these to achieve group consensus (Howe 2010; Mercer & Howe 2012; Mercer & Littleton 2007). And doing so was a need to break the silence inside the classroom.

Lion Pedagogy: Dictatorship in a Classroom

Who is the king of the jungle? The lion is considered the king of the jungle, its role often symbolizes the power to dominate others with its muscular power and courage to suppress and threaten its prey. I have metaphorically used lion pedagogy for teacher-oriented classrooms. Lion pedagogy resembles teacher-centered classes where teachers play a vital and strict role. Where a teacher is superior and rules over students. Students' questions and opinions are not welcomed under this pedagogy. Indeed, the students are not provided with an opportunity to share their views and opinions to make the communication two-way. It is simply one way and teacher-focused class. The following narrative '*Me and my stick'* resembles the true reflection of the Lion pedagogy.

I and my Stick

11 years back, when I was allowed to take classes at the Secondary level in one of the schools in Jhapa (a district in the eastern part of Nepal). At that time, teaching was the most respectful profession for me and I had the assumption that teacher earns respect when they are strict. I started giving classes there and from the very beginning school head teacher, vice-principal, and parents wanted me to be firm and strict with my students inside the classroom; even the management expected me to be harsh with the student. I was following my assumption and my senior as I was a novice teacher at that time. Surprisingly, the school liked the way I was controlling students with my strictness. I was offered to take extra classes in the morning. As far as I remember, I used to roam around with the stick and if I found any kind of wrongdoing no matter if it related to the academy or behavior, students were punished with the stick on the spot. I was the lion not only of the classroom but of the entire school.

In those days, I was a novice teacher, I had to do homework before taking class, and I myself practiced mathematical problems at home most of the time. With practice, I felt proud to demonstrate it inside my classroom. I wanted pin-drop silence in the class whenever I taught them. I never enjoyed the cross-questions in the class and also found that students were also less critical enough to ask the questions. I was wired on that way. We had forty-five minutes of class and I felt it was a waste of time to have class discussions, I had never seen any other teachers interacting in their class as well. The teacher dominated the class, and my assumption and expectations from the seniors had created my personality very reserved, this might not have created room for students to explore the content and asked questions in a very participative way.

During those few years, I taught the students not to explain the derivation of formulae. Instead, I asked them to mug up. They were asked to memorize the formulae taught in the class. If students were unable to answer or fail to show their memory power, they used to be beaten very badly regardless of how good and honest they were. This was what I was asked to do on the first day of my school by the head teacher. Scolding them was very obvious and mostly female students used to cry. When I recall these memories, I feel guilty about why I was not mentored or guided to promote respecting students' emotions and behavior. Those days I and my entire

school team used to feel proud of such kinds of so-called achievements and teacher attributes.

Throughout that year my teaching pedagogy focused on myself and accepting the school leaders' opinions and passive listening to my students. When I entered the third year of teaching in the same school, I was even rewarded as 'Best teacher' of that institution as many students achieved good marks in my teaching tenure.
Now, when I see that certificate, I question myself……Did I teach well?
The 'I and my stick' narrative explains the lion pedagogy and my involvement there as a teacher playing the role of the lion in the class. But now several questions come to my mind such as …. Was I a very realistic teacher? Was it my achievement? Could they contextualize their learning? Will my students remember me as a 'teacher who contextualizes learning' or as a 'Stick teacher'? I used to perceive mathematics learning is to reproduce knowledge and practicing mathematical equations several times in the copy. I worked hard but I could not gather the skills and empathy skills to be a better teacher. I lacked the skill one potential teacher needs to have. I could not feel students' needs and never tried to keep myself in their shoes. I could not be the teacher who resolves the problems of the students due to a lack of understanding of my learner's point of view. For me, it didn't go through a successful tenure of teaching though I was awarded (from today's perspective).

Yes, now I understand the difference between teacher-centered and student-centered classrooms. I understand the benefits of the learning spaces among them. I even understand what I was practicing and what I need to do. I got that "when education is teacher-centered, the teacher retains full control of the classroom and its activities" (Otukile-Mongwaketse, 2018, p.12) and he/she creates a fully controlled environment in every single learning experience of the students (Emaliana, 2017). This is "an educational system based upon rote learning and memorization" (Muganga & Ssenkusu, 2019, p.16) which relied on the behaviorist theory and is based on the idea that behavior changes are caused by external stimuli (Skinner, 1974).

I found my lion nature in the classrooms also bounded the students learning and creativity. But on the other hand, if a teacher is guided by the student-centric approach then the "teachers avoid transmissions of knowledge directly" (Serin, 2018, p. 165) and create a learning space where students can explore their creative thoughts "to make sense of what they are learning by relating it to prior knowledge and by

discussing it with others" (Brophy, 1999, p.49). The author like Mart (2013) states that "passionate teachers know that it is their role to encourage students for an active learning and concern themselves with promoting students' intellectual and moral development" (p. 438). The scenario shows that student-centered classrooms can promote actual learning for the learners. As a PAR team, we have also tried to maintain a student-centered environment for the learners in our action plan. I can proudly say that each student's voice was heard and tried to integrate with our STEAM plans.

Discovering Mathematics in a Culture: Shifting Towards Contextualization

Nepal is a multicultural, multilingual, and multicast country. Even the same cast of people residing in different parts of the country has developed and adopted different cultures. Culture is the ideas, customs, and social behavior of a particular people or society. Culture can be grouped into two different kinds of categories, tangible culture, and intangible culture. Tangible culture includes traditional clothing, tools, buildings, artwork, monuments, music, and modes of transportation, whereas the values, beliefs, feelings, opinions, perspectives, and assumptions are the intangible culture. For mathematics teaching knowledge of tangible culture as well as intangible culture is equally important because mathematics is the cultural product. Due to the presence of too many cultures within the small territory, teaching mathematics is a culturally challenging task.

Nepalese classrooms are multicultural and multilingual (Panthi & Belbase, 2017). Students from different cultures and linguistic backgrounds come to the same classroom. They practice one type of culture at home and must adopt another culture in school. Most mathematics teachers in Nepal have been blindfolded by the view of mathematics as a collection of symbols, mathematics as a body of pure knowledge, and mathematics as objective knowledge (Luitel, 2009). In my opinion, we teachers need to address culturally responsive pedagogy in mathematics teaching. Richards, Brown, and Forde (2007) state that a culturally responsive pedagogy facilitates and supports the achievement of all students. In a culturally responsive classroom, effective teaching and learning occur in a culturally supported, learner-centered context, whereby the strengths students bring to school are identified, nurtured, and utilized to promote student development. Culturally responsive teaching happens when a teacher bridges the gap between what students learn in the classroom and what they experience in their cultures and their communities. The goal behind

culturally responsive teaching is that students develop their voices and become academically successful, critically conscious forces of change in their communities.

After completing my schooling in Fikkal, the heart of one of the most beautiful mountain districts, Ilam, I climbed down to the Terai for my higher study. To support myself financially, I started teaching mathematics in a private school. After the completion of grade 12, I again moved to Kathmandu for Bachelor's degree. As I had already acquired experience in mathematics teaching, I easily got another teaching job in Kathmandu. Immediately after taking the final exam for my Bachelor's degree, I was offered to join one school in Salleri, the headquarter of Solukhumbu district. Within the short span of almost a year, I became one of the lucky persons to learn and teach mathematics in all three geographical regions (Himal, Pahad, and Terai) of Nepal having different cultural settings.

My teaching experience in Salleri was unforgettable. I was told by the principal that the mathematics performance of the students was not satisfactory and I had to improve it. I confidently told the principal, "Don't worry about it. I am an experienced mathematics teacher. All of my previous students had secured good marks and the same will happen here too". But, as I began to teach there, my confidence weakened day by day. Previously I was teaching students of the Hilly and the Terai region. I was familiar with their culture and surrounding. I could easily bring their culture into the classroom, but there the culture was different. For the first time, I was teaching typical Sherpas, Tamangs, and Rais. Their society was different. Their language was different. Most of them were Buddhists, some of them followed Kirat and a few of them followed the Hindu religion. I felt difficulties even pronouncing the names of some of my students. After teaching there for about three months, I attained teacher training provided by the Hillary foundation at Salleri. During that training, one of the trainers encouraged me to use local material in mathematics teaching. I shared my problems with him and he personally advised me first to understand their culture and give examples that are familiar with their culture. Then I began to explore their society and culture. After school time, I began to spend time with the local people. Gradually, I began to understand the frequently used local words such as 'Tesi Dele, Sewaro for Namaste, Boju for grandmother, Aai for mother, Appa for father, Rogding for a village near the river, and Armading for a village at the top of the hill and so on.

While teaching the area and volume of a wall, in Kathmandu valley and in Terai, I used to mention bricks frequently. There all the houses are made of stones and wooden planks. I did not see even a single brick in Salleri and Phaplu. In the course book, I had to teach the question of the type "how many bricks are needed to build a wall?" There I began to teach how many stones are needed to build a wall of a given dimension. How many wooden planks are needed to build a house? While teaching the chapter 'ratio and proportion' of grade nine, we frequently encounter the word problem containing two different types of rice. A particular problem looks like this, "In what ratio mansuli rice of 5 kg costing Rs. 30 per kg and basmati rice costing Rs. 40 kg should be mixed to get a profit of Rs. 2 per kg?" I found such type of problems are less relevant to the students of the middle and upper Solukhumbu district because most of the students have not seen rice fields. They are not familiar with the types of rice. Few of them might have seen husk-free packed rice in sacks only. Instead of rice barley was suitable there. Potato is the main agricultural product of Solukhumbu district. 'Rildok' is a famous Sherpa dish made of potato, which is taken with hot soup in the winter season. In Solukhumbu district non-Sherpas also equally enjoy this dish. A question like, 'how many kilos of potatoes are needed to make 'Rildok' for a family of five members?' sounds more relevant to the students of that locality but again this question might be less relevant to the students of other communities or contexts who have got no idea about 'Rildok'. After using local materials in teaching, and bringing their culture as far as possible in the classroom, I could able to maintain the academic performance of my students at a satisfactory level. Honestly speaking, I could just maintain my prestige, but not fully satisfied with my teaching because I found lots of cultural incompetence within me.

Contextualization is the art of relating textbook mathematics with the mathematics of the locals. In other words, it is the fusion of classroom mathematics with ethnomathematics, the mathematics practiced by people in their daily life. When students do not find mathematics contextualized to their community, they have to struggle to learn mathematics (UNESCO, 2008). Contextualization is much easier than we think. Let me present some examples.

Figure 4.2

Nanglo[3]

The above picture might not be new for the Nepali people. Most Nepali use "Nanglo" in their home for kitchen stuff. We can use it to teach the concept of the circle in the classroom. We can easily give a concept of the circumference, diameter, radius, and area of the circle showing this "Nanglo". Let us observe it. We can see green horizontal and vertical stripes. These stripes are generating squares inside the '"Nanglo". At the center of the "Nanglo," there is a big square. Inside this big square, there are four small squares. Outside the big square, there are incomplete squares and at four corners of the big square there are four small geometrical figures which look like a right-angled triangle, but due to the curved hypotenuse, we cannot claim it a perfect right-angle triangle. A good mathematics teacher can impart lots of mathematical knowledge from it to the student. He/she can generate lots of mathematical questions from it such as-

1. *Students, can you find its radius?*
2. *Can you find its circumference?*
3. *Can you find its area?*
4. *How many complete squares can you see here?*
5. *How many small squares are there?*
6. *What is the area of small squares?*
7. *What is the area of the big square?*

[3] A typical Nepali material made from bamboo and used for kitchen purpose

The longest green stripe is the diameter. We can measure it by using a measuring tape. Half of the diameter is the radius. Then we have the formulae to calculate circumference and area. Students can use their scale to measure the side of one small square. They can easily apply $A = l^2$ [A=Area and l=length] to calculate the area of a square. The area of a big square is four times the area of a small square. In Grade seven (in the Nepali education system), there is a chapter 'Tessellation' which deals with patterns generated by geometrical figures. We can also use "Nanglo" to teach tessellation.

Have we ever thought about the "Nanglo" makers? Are all the "Nanglo" makers know the textbook mathematics? Have they ever been to school? The answer is no. I still remember my grandfather making "Nanglo" in the yard. He had never studied mathematics in his life. I never saw him measuring the length of each bamboo stripe (Choya) by scale. Except for his hands and fingers, I do not remember him using any other measuring device to make "Nanglo" full mathematical arts.

Figure 4.3

Paral ko kuneu[4]

[4] *Straw pile*

This is the straw pile (paral ko kuneu) from our field in terai (Jhapa district). My grandfather is fond of cattle. There is a long shelter made for them where many cows and buffalos are kept. As we have our own rice field in the Terai region (Jhapa), every year we harvest the rice grains and store the straw. We (me and my maternal uncle) made this pile with the help and instruction of our grandfather. He taught us how to build it. Before making the pile, while making the pile, and even after making the pile, I felt difficult to figure out the mathematics inside it though I have been teaching mathematics in schools. But now, I see it as a combination of the prism and the pyramid. Its base is either a square or a circle. It has four rectangles, four isosceles triangles, or a circular round. It would be wonderful if I bring my students here and allow them to find the base area, Lateral surface area, total surface area, and volume of this pile. And, I will definitely do it if I get a chance to facilitate in a such cultural group. Like other mathematics teachers, I had also given the example of pyramids from Egypt while teaching pyramids though none of us (teachers and students) has reached so far. We have lots of traditional houses, and temples in the shape of a combination of prism and pyramid. The roofs of most traditional Nepali houses are in the shape of a triangular prism.

The picture below is the bundle of maze cob (makaiko Jhutta) made by our father and mother. I have also contributed to few of them. Here the mathematics is each bundle consists of ten cobs. And its advantage is we can store the maze in a rope or in a bar as shown in the picture for a longer time. It takes less space and saves it from rats and other insects. In our country, we save maze cobs in a big 'thangro[5]*' which looks like a combination of cylinder and cone or like a cuboid.*

[5] Typical Nepali word to describe the pile of maize as shown in the figure above

Figure 4.4

Maize storing styles and a mat made up of maize kernel

The fourth picture above (in figure 4.4) is of a mat (Sukul) made by my grandmother. The majority of the married women of my mother's and grandmother's ages made such mat at their homes in our village. I have seen her making mats for our personal use since my childhood. She can read Nepali but can't write properly. She had never been to school. She does not know academic mathematics. I have seen her using her palm span (Bitta – the stretched distance between thumb and little finger and Kuret- the stretched distance between thumb and fore index) to measure the length and breadth of the mat. Like my grandmothers, lots of Nepali literate and illiterate mothers and fathers are making mats with beautiful patterns inside them. This can be related to the ethnomathematics of our culture. We, mathematics teachers, are teaching our students how to draw rectangles and squares on paper. We are teaching how to find their areas and perimeters using a pen and pencil. It is high time to invite our mothers and fathers to our schools to train our students to teach this mat-making technique. And this is what STEAM pedagogy advocate for in this today's educational practices.

In the picture below, we see a wicker basket (doko) in an inverted position. It is used all over Nepal to carry grass, crops, compost fertilizer, and so many other

things. A doko can be useful material to teach geometry. It has straight lines, curved lines, and horizontal lines. Its base is square-shaped. Its mouth is circular. It is narrow at the base and wider at the top. It has a variable radius. We can interestingly teach our students how to find its base area, curved surface area, and volume because it is neither a perfect cylinder nor a perfect cone. It would be a good project work for our students because they have to apply the mathematical concepts in a creative way.

Figure 4.5

A protected place for chickens

In the picture above there are some hens. I have taken this picture from one of my friend's homes. One of the hens is picking grains from a container. Actually, the container is an old brick key. It is used in making raw bricks. Now let us search mathematics in it. If we have to find the volume of a brick key, just have to find the volume of a brick, by multiplying its length, breadth, and thickness. I believe it would be more fruitful if we practically allow our students of grades seven and eight to calculate the area, perimeter, and volume of brick because it will be stored in their long-term memory.

Let me start another scene in shifting toward contextualization.

Nepal was shaken by a massive earthquake of 7.8 magnitudes on 25th April 2015. It was a painful experience for all the Nepalese. I am sad about the loss of lives of many Nepalese. Like others, my friend's home was also crumbled down in Dhading (the district in the western part of Kathmandu; the capital city of Nepal). But

personally, I felt lucky because all of the family members were safe. Unfortunately, I was also there at his home. After spending three nights below the shade of a guava tree my mathematical mind began to work. A few days before the earthquake, my friend's father had brought some pieces of bamboo for floriculture (for the plantation of roses and other flowers). I had seen a bamboo restaurant in Solukhumbu district. We decided to make a bamboo house instead of planting roses and I shared my plan with my friend. The next morning, we (me and my friend) went to a nearby Village: Thakre. Thakre is a beautiful village that is above the Dharke Bazar. One can reach Thakre village with 1 hour ride on motorcycle in the north direction from Dharke Bazar. This is the homeland of 'Pahari' who are experts in the bamboo craft. After talking with some of the villagers we got 'maila dai', the expert bamboo homemaker. My friend told him that we have got around 100 pieces of bamboo at our home and want to build a house of size 35 feet long, and 30 feet wide. He seemed unschooled but immediately he replied ''your dimension is not appropriate. You should go for 40 by *20 and you need 500 pieces of bamboo." I asked him without calculating, how can you say? He replied with a pleasant smile – experience is also something.*

The next day, 'maila dai', came with his three more friends. Due to the earthquake, schools were closed, so both of us could involve ourselves in the home-making process. I sketched on paper with a pencil. We calculated every small detail like the number of rooms, the number, and position of windows and doors, the terrace, and the elevation of the roof and consulted with 'maila dai'. I used my academic mathematics and 'maila dai' who had never been to any school, used his experience to modify my plan. Through the fusion of academic and non-academic mathematical practices, a beautiful bamboo house was constructed on a low budget. Some of the pictures of that bamboo house are:

Figure 4.6

Bamboo house-made during earthquake time

From these pictures, I want to discuss ethnomathematical practices found in our community. 'Maila dai', and his friends, I like to call them 'Thakre brothers' have not taken any formal education. They are not even trained formally to make a bamboo house from any vocational institute. They have learned it from their earlier generations. I had told them to fit the windows of my crumbled house in the bamboo house. They not only fitted the old windows but also kept a few triangular windows, semi-circular windows, and rectangular windows with a semi-circle at the top to give a beautiful look.

Figure 4.7

Old windows assembled in a new bamboo house

In the picture above at the top of a circular window, there is a big bamboo. It is like the tangent to the circular arc. Below the window, there is another big bamboo. Between these horizontal bamboos, some vertical bamboos are like perpendicular lines. I collected those pictures from my friend and he added that the bamboo houses are still in use for poultry farming. He added that two years back they constructed another concrete house for their living.

'Thakre brothers' are just examples. The whole world is full of such talented people who are practicing ethnomathematics in their own culture and society. Their mathematics can be integrated into mainstream mathematics because academic mathematics and ethnomathematics are the two sides of the same coin. Moreover, I believe that today's academic mathematics was also ethnomathematics once upon a time in history.

Talking about another interesting scene from our society, I come up with the measurement system of grains and household items in our context. In Nepal, we use 'mana and pathi[6]*' to measure the volumes of crops and other household items. We all know that one pathi is equivalent to eight manas. Nowadays, I am living in Kathmandu valley and Pangaun is a small village in Lalitpur district. It is the village of Newars and is famous for the construction of 'pang' in this locality. I found that 'Pang' is like a 'pathi' but it is equivalent to nine manas. This is the different mathematical practice in Pangaun and its peripheral villages. I have collected this information from one of my classmates in M. Ed. Study.*

[6] A type of local measurement system practiced in Nepal from ancient time

In order to contextualize the content of mathematics, learners need to get exposed to an environment where they can develop a conceptual understanding of their real scenario (NCTM, 2000). Yee and Bostic (2014) stated that to contextualize a problem can mean to relate it to a specific physical situation, but it can also mean to relate the problem to other ideas. The local materials and the contextual scenarios can give a holistic picture of the problem in the learners' context.

Teachers can easily understand the concept but demonstrating and linking ideas to concepts often challenged students with poor logical reasoning. The dual analysis perspectives of a teacher and learner are often complex (Pólya, 2004). At this level, teachers might stand on their feet, asking questions, making points, gesturing, writing key ideas on the board, encouraging, correcting, demonstrating, and so forth" (Schug, 2013, p. 94). Such practices in the classroom can develop the learners from the level of knowledge, skills, and attitudes at the same time linking with learners' context and culture. Visual representations such as diagrams, tables, and graphs are used to express the clarity of conceptual understanding once learners gain knowledge on the mathematical topic (Lomibao, Silk, & Luna, 2017, p. 1). A teacher should identify the social dimension and understand the culture of learners to tackle social challenges which learners face in their real-world practices and need to find solutions for them. At the same time, learners' decision-making skills which are also an integral part of problem-solving associated with making sense of the problem and probable solution for real life are beneficial for enhancing learners' better understanding (Schoenfeld, 2011). By including local materials and sociocultural examples in our classroom, we can ignite the affinity of mathematics in our students.

Death of Silence

It was a day in 2018, the principal of my school and I were sitting on the school's grounds having tea in our leisure time. It was a casual meeting with the principal. We discussed how my teaching practice has been changing day by day.

Principal: *Sir, I heard from the students that you are changed nowadays. You are making groups in the class and allowing students to speak and discuss inside the class…. You were very strict before, how did it happen, sir? Your classes used to be very silent, as no one was inside when you first came, do you remember I often came to your class? The silent environment sometimes made me a fool and I thought that no one was inside but the classes were going on….*
(Hahahahaha)

Figure 4.8

Picture of our meeting made by a student

Me: *(With a short smile) Yes sir, nowadays I am practicing some progressive pedagogies in teaching mathematics.*

Principal: *Sir, are these the same teaching styles that the principal from the so-called progressive schools discuss in our meetings and conferences?*

Me: *Yes sir, many schools in Kathmandu Valley claim themselves as progressive school, they might be adopting those progressive teaching learning methods.*

Principal: *That's great sir…. (With a smile) It is very difficult to believe in our eyes that a teacher only with a baton and anger on his face is carrying a laptop in his hand while entering a classroom. (hahahaha)*

Me: *(Taking a sip of tea and a short smile) Umm… I am trying to use ICT materials in mathematics which can help students in understanding the concepts of the mathematical ideas and can make meaning from what they have learned. Computer software like GeoGebra, and Desmos, are very helpful in teaching graphs and solid figures with 3D images. Students can easily make sense of mathematical phenomena. It is even very easy to operate and does not consume much time for me also to create the materials.*

Principal: *That's great sir… Do you find this progressive method as you told me earlier is effective enough to teach mathematics? Are they applicable at the lower level and in other subjects also?*

Me: *Why not sir… (I took the last sip of tea from the cup and continue) Progressive pedagogies do not only mean engaging students in groups and using laptops in classrooms. There are so many other approaches that we can adopt in mathematics, other disciplines, and lower grades as well. Group work might be the easiest one to adopt for most teachers in any grade.*

(Coordinator of the school also join the meeting)

Principal: *Santosh sir…. (Coordinator) have you ever noticed any changes in the teaching styles of Sandip sir? He seems very changed nowadays… We were discussing this issue only…*

Coordinator: *Yes sir… I have already discussed this matter with Sandip sir. He is practising some contemporary and comparatively new practices in teaching mathematics which he is learning at his university.*

Principal: *Ohh! Is it? Yaa… I am observing some changes in him then after when he joined his Master's study.*

Me: *(With a pleasant smile) yes, sir, I am trying to integrate the teaching-learning approaches which I am learning from my teachers. Nowadays I am reflecting on my own practices also and trying to modify my way of teaching with these so-called contemporary practices.*

Principal: *Sir, what do you think about sharing these ideas with our other fellow teachers as well? Are the resources of our school enough to practice those pedagogies in early grades also?*

Me: *Sure sir… I am ready to share it with my fellow teachers. Such approaches will make our classrooms lively and help students to learn in a better way. We can adopt those activities which are affordable for us and engage students in the learning process rather than limiting the classes to the teachers' lectures.*

Coordinator: *I have observed your classes and consulted with the students as well regarding your approach. Students are very happy and motivated in mathematics learning. I have seen you taking students in the computer lab, dining hall, and ground in mathematics class. I have never seen you this much friendly with the students before. One student was sharing "I feel much more comfortable with Sandip sir*

nowadays in asking questions in class, previously he was not like this, and I had never dared to speak with him".

Me: *(With a smile) Yes, sir. Nowadays I am practicing group work, pair-works, and collaborative work where students get enough space to share their ideas with each other. I found that students who need more support can learn from his/her friend in a better way than a teacher because all students might not feel comfortable asking every query the teacher. I found my strict nature in the classroom prevents students from asking about their difficulties and only so-called high achievers are comfortable sharing their difficulties. So nowadays I am trying to make students comfortable enough to share their difficulties and queries with me. I am trying to break the barriers between me and my students, so I am modifying my way of teaching and learning. I think the hybrid way of teaching or blended approach of conventional to progressive pedagogies is helpful for me to uplift my professional skills.*

Ting, Ting, Ting, Ting (Bell rang 4 times for the 4th period)

Coordinator: *Okay sir. I do have a class in IX. Let me leave.*

Principal: *Okay sir. Now we will also leave.*

Me: *Okay sir… we can plan for a session in the upcoming days.*

Principal: *Sure sir… we will plan a session very soon.*

The above scenario with the principal is about collaboration and group learning in my mathematics classes. It shows my transformation from a draconian teacher to a student-friendly teacher/ facilitator. The term draconian here refers to the terrific nature of teachers that do not allow students to interact with the teacher. The metaphor 'death of silence' is used as the end of pin-drop silence in my class. Group work is a broad term covering several techniques in which two or more members are assigned a particular task involving collaboration. The students within the groups can solve complex problems with minimal assistance, being consistent with the real world (Karim, 2015). As a mathematics learner and a teacher, I experienced that the majority of the students at the school level take mathematics as a difficult area to be learned and feel comfortable solving problems in a group. Collaboration and teamwork emphasize the process of cooperation and require every individual to work together toward a common goal (Lai et al. 2017). The heterogeneous group of students can share their knowledge and problem-solving skills from so-called high achievers to so-called low achievers. Collaboration has to be developed among students as part of their k-12 education (NEA, 2012) which not only limits students in

the learning process but can foster additional skills like communication and collaboration skills. Collaboration skills are hyped day by day due to the demand for individuals who are confident in both people and technology (Hooks, 2020), and it is the social skill that can enhance and promote success rate and harmony among group members (Steinfeld, 2020).

The role of group work in mathematics education is crucial, as it fosters a collaborative environment for students to ask questions, engage in discussions, listen to each other, take ownership of their learning, offer constructive criticism, and develop a sense of responsibility. Research in this field highlights that group work is not only effective for social reasons but also has a positive impact on mathematical learning. In comparison to competitive and individual learning systems, group learning is more beneficial in terms of academic achievement. It also helps to enhance students' attitudes toward mathematics and overcome their anxieties related to the subject.

Recent studies grounded in sociocultural theories of learning stress the significance of involving students in the process of "constructing knowledge, negotiating meanings, and participating in mathematical communication" (Moschkovich, 2002, p. 190). Learning is seen not as a solitary process that occurs solely within the mind, but as a socially mediated experience that is influenced by community practices, cultural forms, language, and representations (Saxe, 1999).

Laptop as a Teacher: Shifting Towards Technology

Now, I am in my late twenties. I am doing my M. Phil in STEAM education at Kathmandu University. One and a half years back, I completed my Master's in mathematics education from the same university. I still remember the orientation class for my Master's degree. It was August 6, 2018. The orientation class changed my perspective on learning. I had the insight that computers can be our teachers.

Until the completion of my Bachelor's degree, I used to think that I could learn mathematics either from teachers or from books. As teachers used to solve only the selected problems from the textbooks, I had to rely on worked out examples and reference books. While learning from worked-out examples and reference books, I faced two major problems. First, it was time-consuming. Second, I could not understand some of the steps and I had to memorize those steps. Most of the rote memorized steps were easily used to evaporate and I was again left with my incomplete algorithmic steps, losing the threads. This all started during my teenage.

In my first phase of teenage life, I was struggling only to secure a decent mark in mathematics. Initial years up to the basic level examination (up to Grade 8), I was self-motivated to secure good marks in mathematics, gradually I less enjoyed this subject in a few areas like geometry, and I started to develop anxiety and fearfulness for mathematics subjects, it was a time when my self-confidence was lowered and bitterness towards this subject in Bachelor's level that made me feel I was a weak student, for me, facing a mathematical test was like facing a war. My enemies were numbers and mathematical symbols printed on question papers. The subjects like algebra and mathematical analysis were found in a different language.

I felt a bit comfortable learning mathematics and any other ideas when I was pursuing my M. Ed study. The university taught me to utilize the computer as a second teacher where I can post my difficulties and can access its solutions from multiple sources. As a second teacher, computers helped me to acquire mathematical knowledge from multiple perspectives and visualize abstract ideas. More importantly, my university taught me how to integrate technology (ICTs) into mathematics teaching. This skill helped me to project my identity as an ICT-friendly mathematics teacher in my working area.

Use of Computers to Acquire Mathematical Concepts from Multiple Perspectives

After taking a few classes at my University, I realized that a teacher only teaches how to swim. None of the teachers swims for their students. Students themselves have to swim to reach their destination. However, teachers can show their students the right direction to swim and are always ready to rescue their students when students are drowning. That is why teachers are the facilitators. My facilitators enabled me to swim in the use of a computer to search for useful resources from the vast ocean of the internet. I surfed many websites such as Oxford owl, White Rose Maths, and Khan Academy.... to be clearer on mathematical concepts in doubtful topics. I was using YouTube only for entertainment. When I began to search mathematics on YouTube, I found innumerable mathematical videos prepared by teachers and experts from all over the world. I found the teaching methodologies of some of the teachers are found effective. When I watched multiple videos for the same topic, for example: say - random variable, I fully understood the concept as the different teachers taught the topic by giving different examples. Watching multiple videos for the same topic enhanced my analyzing power and helped my mind to

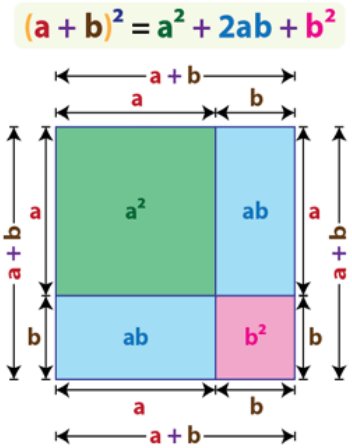
modify, rectify, amplify, and accommodate the concepts in long-term memory. I also found a few math lovers making TikTok videos to nicely present their mathematical ideas and techniques. I learned many short tricks on multiplications from TikTok. For example, the multiplication of any digit number by 11. When 11 multiplies 32 the product is 352. We need not have to use a calculator or use the traditional multiplication method using pen and paper. We can multiply within our heads. We just have to place the sum of unit digit 2 and tens digit 3 in between 3 and 2 to get product 352. Similarly, when we multiply 75 by 11, the product is 825. In this example when unit digit 5 and tens digit 7 are added, the sum is 12. Here the carry-over 1 should be mentally added to the tens digit 7 to obtain 8 and 2 should be kept in between 8 and 5. The idea can be used to multiply the number of any digits by 11. These days' people (mathematics teachers, writers, and students) are keeping their innovative ideas on social media. Just today morning I opened Facebook and found a mathematical question (solve: x^x =9^(x+ 81)) posted by one of the facilitators from the same University where I am studying. In the comment section, I found the solution techniques. "Take logs on both sides." It was the comment by most of the commenters. However, one of the commenters commented "81" as an answer and posted the complete solution procedure just by the use of the law of indices. I could not help myself solving the problem by taking logs on both sides and obtaining the answer 81.

Use of Computer to Visualize Abstract Ideas

All the school graduates know the formula of (a + b)^2. They can promptly tell (a + b)^2= a^2+2ab+b^2. If we ask them why the expansion of (a +b)^2 is a^2+2ab+b^2, how many of them can answer? I guess very few. I solved innumerable problems in school and college by using this formula without knowing (a +b)^2 is an area that is equivalent to the sum of areas of two squares and two identical rectangles. My school teachers just taught me the application of the formula. It would have been much better if he had taught me the formula visually. Like me, many students are still there who have not visualized such a formula, yet.

Figure 4.9

Visual representation of (a + b)^2= a^2+2ab+b^2



For a better understanding of mathematics, visualization plays a vital role. Good mathematics teachers frequently use drawings and pictures. Use of computer application software such as Ms- Paint, Ms- PowerPoint, Desmos, GeoGebra drawing, and pictures more vibrant. I have found a misconception among many students about Pythagoras theorem. If we ask what is Pythagoras theorem, they just say h^2 = p^2 + b^2. Further, if we ask what is the meaning of h^2 = p^2 + b^2, the probability of obtaining the answer is low. Many students think Pythagoras theorem is a formula to find the missing side of a right-angle triangle when two sides are known, which is true to some extent. However, the meaning of Pythagoras theorem is not limited only to that rather it refers to the area of a square formed on the hypotenuse being equal to the sum of areas of the square formed on perpendicular and base. By the use of GeoGebra, the meaning of the equation h^2 = p^2 + b^2 can easily be shown through an animated figure.

Some of the chapters such as mensuration, linear programming, equation, and graphs can easily and effectively be taught using both online and offline computer applications. The use of computer-based mathematics teaching software enhances spatial reasoning, boosts abstract thinking, and ultimately uplifts mathematical reasoning. "If technologies are used appropriately, they can accelerate the effective learning of the students. Teachers and students can investigate more mathematical ideas with the help of proper use of technologies" (Dahal, Shrestha, & Pant, 2019, p. 324). Research like Bakar, Ayub, and Tarmizi (2010), Dahal, and Dahal (2015), and Bismarck (2009) also show the importance of technology in mathematics education. I experienced that ICT could play a crucial role in the teachers'

transformation in their teaching styles (Sanchez & Aleman, 2011). Teachers and students can explore and widen the horizon of their interest area with the help of ICT tools. ICT "is an engine of innovation in education, and we can see in the 21st century, the psychological, socio-economic, and technological changes it brings to school" (Das, 2019, p. 2). ICT-integrated classrooms can create a learner-centered environment and engage the learners actively in the learning process (Lu et al., 2010). In this way, I got a lot of opportunities and success from the internet to foster my mathematical concepts and I encourage my students also to become familiar with the ICT tools which are considered here as a second teacher.

Transformative Teacher: A Lifelong Learner

The time is not rigid, the world is changeable, and the need and demands of yesterday might not be the need and demands of today. The narratives like *"we have struggled a lot for study, bare foot, dirty clothes, not enough to eat, hours of walking distance for the school. If we have got opportunities like you (students/children) we would not be in this place. We would have a better life."* These dialogues were very common for us during my childhood. Not only the teachers but our parents also used to deliver a similar dialogue for us. I even tried to do the same in the earlier days of my teaching carrier.

I realized that we as a teacher always tried to compare our students with us and with our abilities and blame them as they cannot compete with us (teachers). I found that I as a teacher tried to pose my difficulty and constraints to the students without knowing their needs and interest. *"If I can do this, why you can't?"* This was the most common statement that I have heard and practice as a teacher. In reflecting on those days, now I can realize that I was not able to update myself. I was not even mindful of the need and abilities of students. In my experience still, the majority of teachers perceive themselves all-in-all after gaining a certain level of degree and continuously reproduce the same knowledge for years and years. They are less merciful for the need and interests of the learners.

At this moment of inquiry, with deep introspection, I realized the need for updated teachers as per the need and interest of time and context. The mismatched between the learners' interests and teachers' interests might create a gap in the learning procedure. For this a teacher need to update himself/herself with a mindful thought and need to reflect critically on their actions and modify their approach as per the need of the learners. At this point as a critical self-reflector, I found my spiritual

practices developed me as a life-long learner in the academic field. Spirituality for me at this stage refers to the critical self-reflection upon myself as a mindful being and updating me to a better version of myself.

Reflecting on my Spiritual Practices

Being a member of a Brahmin family, the word spirituality was never new to me. I had grown up hearing mantras and holy songs each day in my home. We even used to sing holy songs while taking baths like 'hara hara gange'. Chanting Hanuman Chalisha and Gayatri Mantra was most common in our family. I saw my grandparents reading the Mahabharat, the Ramayana, the Bhagwat Gita, and other holy books in their leisure time. I can remember that day when my father taught me to read the Bhagwat Gita for the first time. It was early morning and we both (me and my father) were in the kitchen near Ageno (a typical place to burn fire) sitting in a pira (small bed-like seat made up of wood), a kettle of water was boiling on the odan (tripod stand), and I was learning.

And so on…

Figure 4.10

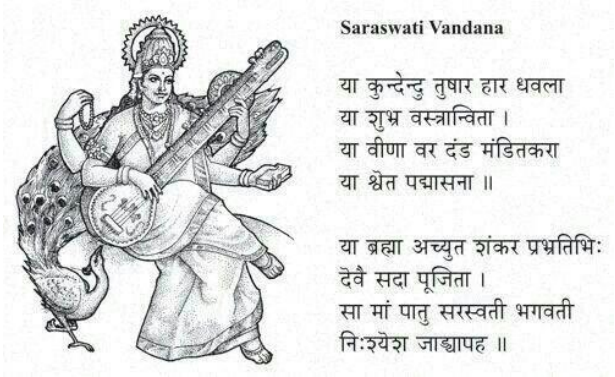
Starting two lines in Bhagwat Gita: Aadhaya 1st[7]

धर्मक्षेत्रे कुरुक्षेत्रे समवेता युयुत्सवः।
मामकाः पाण्डवाश्चैव किमकुर्वत सञ्जय॥ १॥

I still have its Nepali version and I read it sometime. I found this book contains the highest esoteric doctrines which are the major essence of the Vedas. The manner in which the Gita describes the virtues, glory, and secrets of God, is hardly found in any other scriptures; for in other books, the

Figure 4.11

Saraswati Bandana, we used to chant in our school



[7] Translation: Sanjaya gathered on the holy land of Kuruksetra, eager to fight, what did my sons and the sons of Pandu do?

teaching is generally mixed up, more or less, with worldly subjects. The book starts with the description of the principal warriors on both sides with their fighting qualities; blowing off conches by the worriers on both sides, and overwhelmed by infatuation, Arjuna gives expression to his faint-heartedness tenderness, and grief. The book is about Arjuna and Sri Krisna discussing Arjuna's faint-heartedness and the Ksatrya's duty to engage himself in the fight.

In addition, I found the book is around two major principal ways and they are Sankhayayoga and Karmayoga. The majority of the male parents in my family like Grandparents, uncles, elder brothers, and a few elder sisters were also fluent in Sanskrit and used to study Holy books. Wearing Janai[8], chanting the Gayatri mantra every morning, and Aapsani[9] before any meal was also in my practices when I was at my home. Saraswoti Bandana in school assembly was also another powerful mantra for me on those days and even today. Those practices in my life were the notion of my spirituality in those days. I used to think that the word spirituality refers to the religious practices in any community people or any individual. From today's perspective, I found that my understanding of spirituality was not enough to explain the notion of spirituality and it is much more than religious and ritual practices.

Spirituality in STEAM Education and Transformative Learning

The above scenario reflects my understanding of spirituality before joining University and before immersing myself in transformative learning and practices. I found the word spirituality in much more mature than my understanding and mature from all the religious practices. In addition, I got that spirituality starts where the values of religion end. It critically reflects on the religious and so-called spiritual practices which I discussed in the earlier section. In this regard, Vogel (2000) recognized spirituality as being "drawn to visions of justice, compassion, righteousness, and peace…embracing more than the material and mundane, or the here and now" (p. 18). This definition of spirituality advocates for the holistic learning and development of a learner. Spirituality for me in this study is to critically reflect on ourselves being mindful of our actions for emancipation. My understanding even advocates for the holistic approach to learning that connects any learner to the ways of living. But as a Nepali STEAM learner, I found a compartmentalized

[8] A holy thread is worn by Hindu men in their body crossing from left soldier to right hip.

[9] Keeping some food from the plate before we eat in the name of God and ancestors.

knowledge in our educational practices. Though CDC (Curriculum Development Center) Nepal has introduced an integrated curriculum in Grades I to III but the approach to how we teach the students remains the same. I found the majority of the teachers are guided by the traditional lecture-based approach where the teacher is all in all and a source of knowledge. I have huge experience gathering knowledge as a passive learner, listening to the teacher, taking notes, memorizing the text for the examination, writing in examinations for the Grades/marks, and forgetting everything after the examinations. The interrelation between various aspects of knowledge, disciplines, and knowing is missing from our educational practices. This educational practice promotes behaviorism and limits humans from holistic development.

As a transformative learner, I came to know that spirituality begins when an individual goes beyond his/her cultural practices in a more mature way. Spirituality begins when someone starts to reflect critically on their own experience and complexities of living in the world and starts to seek the common good and justice for all with mindfulness. The authors Mulqueen and Elias (2000) posit that spirituality plays a crucial role in adult development by imparting significance and unity to one's life journey. I realize that spirituality is free from norms and religions. A genuine spiritual seeker is the greatest rebel who is awakened from the inside and sees the phenomena as it is. They believe that everything comes from one cell (capital cell) and ends in one cell (same capital cell) as argued in Vedic philosophy. In my experience, our STEM educational practices are failed to address those expectations and produce the learner full of hesitations, arrogance, self-centered, judgment, etc. The concept of even-mindedness from Vedic philosophy which rejects dualism and engages the learners in inquiry might add the perspective Arts (A) in STEM and can derive in the form of STEAM with aesthetic beauty.

In my academic journey of M. Phil in STEAM education, I experienced many learning theories among which constructivist, socio-cultural, and transformative learning theories are the major ones where the STEAM approach is grounded. In my opinion, the practices of STEAM education are a change agent in our scholastic practices. As far as I know, the STEAM approach is derived to connect the abstract ideas of our textbooks and curriculum to the learners' real-life context. By integrating arts into STEM subjects, learners can effectively communicate scientific concepts through a combination of visual information such as images, texts, and other forms of media. This approach, as noted by Henriksen (2014), enhances the communication of

science by incorporating both creative and technical elements. *As far as I understand the word 'transformation' or "rupantaran" in Nepali doesn't have a fixed meaning or assumption. The meaning/sense of this word or learning perspective can be taken as contextual. As a mathematics teacher and a STEAM educator, the changes which I have experienced in my teaching-learning practices that can challenge my belief in the status quo may refer to the transformative learning perspective.*

Society is complex and the degree of resilience to play the role of agency should be enough to advocate for social justice and common goals or to advocate for shared purpose and shared interests. The notion of 21st-century education where a learner can merge the new perceived knowledge with the pre-existing knowledge and modify it to find new and innovative thoughts and skills could be the essence of transformative learning. Modifying one's perspective can lead to the creation of a new perspective, which can eventually become a habit of thought for the learner. Transformative learning, as defined by Mezirow (1997), is the process of bringing about change in one's frame of reference. This frame encompasses both the student's habits of mind, shaped by prior learning experiences and cultural influences, and their points of view, which are their beliefs and attitudes. *In this sense, Pandey (2019) also added that "transformative learning inspires learners to reflect and review their existing values to reconstruct and shift these understandings; it involves continuously revisiting and revising assumptions from multiple points of view" (p. 228). Further Bruehlmeier (2010) shows the connection and involvement of "head, heart and hands" in this transformation. Moreover, transformative learning can be considered as the interruption and re-positioning of one's beliefs, values, perspectives, assumptions, and practices. Being a transformative STEAM educator, I believe in the collective form of agency and resilience which cultivates the notions of adaptability and bounce-back in a more mature form. Taking reference to Arjuna from the Vedic philosophy and acting as a doer who is free from attachments, I want to represent myself as a yogic researcher in transformative practices to understand and practice a harmonious way of living. In this regard, spiritual knowing/learning supports enhancing transformative research and practice in STEAM Education.*

Growing up in transformative educational practice at Kathmandu University, the notions of spirituality make an impact on my personal and professional journey. As a transformative learner, teacher, and researcher, I found spirituality as an intrinsic part of the human person (Hay, 2006). In the field of education spirituality in

education is a unique experience for learners that is beyond general meaning-making and interpretation, here learners internalize and reflect and are calm (Love & Talbot, 2009). The dimension of love, care, moral values, and humanitarian behaviors can be guided by spirituality in educational practices. Moreover, it can be considered as a way to find the 'meaning' and 'purpose' of life (Hidayatullah, & Nurkamto, 2020). It is believed that how we teach certain topics or ideas is the actual way of spirituality. Focusing more on the process where learners experience general phenomena is far better than what teachers teach them (Jones, 2005). I found that the transformative STEAM practices can be an approach to the holistic development of a learner and this holistic picture contains spirituality as one of the components.

If you meet the Buddha on the road, kill him! (*Kopp, 1985*)

Being a transformative practitioner, I feel a lack of holistic development in today's learners who are not able to cope with their anxiety, doubt, hegemony, and despair. In addition, I find the crises of patience, trust, acceptance, and the nature of non-starving in today's world. The lack of spirituality in educational practices makes people arrogant in their knowledge and resist them from learning further. The attached picture (bowl with water) at the side can add water unless it is full enough and can't add more when it is saturated. Our educational practices detached from spirituality might be responsible to produce such citizens who are less open to alternative viewpoints and less aware of what is right and true for them.

Figure 4.12

A bowl with water

From the lens of transformative learning, none of the learning can be the end; we need to go ahead, and further. We need to learn "to learn forever" and not limit ourselves to our guru. To fulfill the crises in today's educational practices we must kill the metaphorical Buddha and critically reflect on our own practices to expand our level of thinking and make them beyond personal. We need to seek a window of opportunity with transformative potential large or small. I found that "all of the truly important battles are waged within the self" (Kopp, 1985, p. 7). In this sense, I feel like our educational practice needs to serve in such a way that can produce such

mankind who can fight this battle and can live in harmony. We must always see our feelings of uneasiness as being our chance to "make the growth choice rather than the fear choice."

Wishing to learn, and confusing being taught with learning, people often seek out helpers, healers, guides, and spiritual teachers whose disciples they would become. Taking light from multiple perspectives, sometimes we have to be conditioned by our background and experiences but taking Siddhartha Gautama as a great rebel we need to approach our life with a beginner's mind. A genuine spiritual seeker is the greatest rebel, we have the crisis of rebelling in our worldly community and spiritual perspectives in STEAM education research can contribute to resolving this crisis of the world.

Chapter Summary

This chapter reflects how I was cultivated and nurtured in my academic growth. I have tried to articulate this chapter in such a way that each of the subheadings represents a *chowk* (a small market-like structure found on the road/journey) in my academic journey. In reflecting on my own practices I was guided with transformative notions that emancipate me to a better version of myself. The theory of emancipation advocates for the transformative chance that creates awareness in one's practice. I also experienced a transformative change as a teacher and an educator in teaching mathematics. This chapter reflects my transformation from a positivist teacher practitioner to a mindful teacher practitioner with spiritual practices. Further, these reflections help me to set my position as a STEAM practitioner and a researcher. In addition, this chapter empathized with my readers as the majority of the teacher/practitioners might have similar kinds of experiences in today's context.

The next chapter here reflects my participatory journey as a STEAM practitioner teacher and a researcher working in collaboration with my co-researchers. In the next chapter, you will find how the autoethnographer in this chapter probes into a participatory journey. Such integrated practices are found rarely at the secondary level in our context. This chapter is going to be more interesting and reflective. So, get ready to read something new in our Nepali scholastic practices.

CHAPTER V
JOURNEY FROM THE MIRAGE TO REALITY OF STEAM PEDAGOGY

Chapter Overview

After reflecting upon my experience here, I come up with a contextual picture of my sharing in the PAR field. In this chapter, the mirage of my belief and perceptions towards the transformative STEAM education experienced and able to taste the real flavor in my context. Before this intervention, the picture of STEAM pedagogy in Nepali schools was not so clear and looked like a mirage in the desert but now I delve into the real lake where my skin can touch the water and my heart can feel its hotness and coldness. Let me start sharing experiences participating with my research participants (co-researchers). The participatory contextual practices and critical reflection upon them during the PAR project are presented in this chapter. In this chapter, I have started sharing how I started collaborating with my co-researchers. This chapter is constructed to answer the subsidiary question (a) of the second research question which was.

How did the PAR team plan and initiate the STEAM pedagogy in their context?

I have presented my plan for the PAR cycle (see the detailed plan in Annex I) and the limitation of being technical in a practical class in this chapter. In addition, I have reflected on the interventions (STEAM workshops) for the teachers and my experiences with them in this setting. This chapter undergoes the themes like Reflecting on the need-assessment interviews, emerging research questions, Planning for the STEAM project and integrated approach, and Practical yet technical class: teaching for reproduction.

Our collaboration starts from the start of this study to its end.

Reflecting on the Need-Assessment Interviews

Human history seems to be a continuous failure of the mind and its practices. The rapid growth of the world towards development and economic growth is less able to be addressed by our educational practices. The collaborative discussion with the participant teachers while formulating the research problem for this study gives insights into their practices along with mine. The detailed explanations of their problem are kept in the “problem statement section” in chapter I of this study. In that

section, I discussed the problems around the pedagogical context of mathematics in Nepal and observed myself after going through several types of research and literature, visiting the location of this research study, and having discussions with educators including my experience. In so doing, I problematize my research through three broad lenses: first decontextualized nature of mathematics, second pedagogical practice, and third professional development of teachers.

The first genuine problem is the disengagement of students in the Nepalese pedagogical context where students are less motivated toward learning and have mathematical anxiety which is why there is a decreasing interest in students in learning. One of the participant teachers (Mathematics teacher) in this study argued that "*each year the degree of frustration in students towards mathematics is increasing in order. Many of the students are studying mathematics at the school level just because it is a compulsory subject*". They reflect that students are developing a negative attitude and perception towards mathematics because of the nature and pedagogical approaches that are implemented to present the contents. In addition, they added that they are not satisfied with what they are adopting as a pedagogical approach, but they are not enough aware of the progressive ideas. Learning emphasizes more on memorization, rote recall, and rote problem-solving strategies which make students anxious, and they ended up frustrated.

The scenario of my participant teachers also reflects the lack of professional growth. Two of the five participants reveal that they have never participated in any professional development training in their five years of teaching tenure. Though they are involving themselves for a long time in teaching similar textbooks and curricula, they are reproducing the same phenomena that they had learned when they were at the school level. "*I am teaching in the same way how I was taught in my school because I am not aware of other pedagogical aspects. As a scholar also I am in the IT (Information Technology) field where we never discussed pedagogical dimensions*" argued the computer teacher. For me, their 15 years of experience was one year of experience in matured form. One year in the sense of repeating the same plan and strategy and matured in the sense same technique has been repeated multiple times. Their huge experience in front of a one-size-fits-all approach and priest-pedagogy as I argued in Chapter IV were not enough to address the need and interests of 21st-century learners. Teachers as an ultimate source of knowledge and students as empty vessels were dominant beliefs in many of them. This scenario makes me feel the lack

of some orientation for them and I planned a workshop program for them. The workshop was conducted in two sessions each session of two hours and conducted after the school scheduled from 3:00 pm onwards.

Emerged Research Questions

From our collaborative exhuming, we engaged in the planning and inquiry process. In doing this we came up with an emergent overarching research question. I had prepared some emerging questions on my own based on the need assessment. But that questions got modified in our collaborative discussions. Finally, I got four supportive sub-questions for research question two at this point. And the questions are:

a. How did the PAR team plan and initiate the STEAM pedagogy in their context?
b. How did the PAR team initiate collaborations and negotiations for the STEAM implementation? And, despite the hopeful perspectival transformation, how did the team experience manifold messiness while implementing it?
c. In what ways did STEAM practices make our (PAR team) classroom harmonious and affective driven?
d. How did the PAR researchers develop their pedagogical perspectives/practices for transformative sustainability?

Planning for the STEAM Projects and Integrated Approach

As a STEAM learner and a practitioner, I conducted this research in one of the community schools in Kathmandu during the first semester of my MPhil study. Later, the plan changed, and I conducted this study where I was working. The planning at my level starts from those days when I was shaping my proposal for this study. I had planned this project at two levels first from my level and then from my participants' level. Those plans were discussed down here.

My Planning

In the earlier days, I prepared some projects as our class assignments and some in my interest for this study. I implemented those projects for the students in my regular classes to some extent. My experiences in doing this and the outcomes of those practices give me a positive impact to modify and revise my plan. Being a practitioner-researcher, my initial planning was somehow detailed and more

sophisticated in terms of ideas but later I found those ideas might not always fit in my context.

I am a STEAM learner.

I am a researcher.

I had learned so many theories.

I am a progressive teacher.

I am a progressive educator

I can teach better than an ordinary teacher.

We had worked on designing STEAM projects in our classes.

I do have the best plan for implementing STEAM projects.

Whatever I am trying to do is the best and most effective approach in our context.

Such assumptions and hero-centric nature were dominant in me when I was approaching the collaboration with a school where I was familiar from an earlier time. This might be because I was familiar with the context and they were also familiar with me. Besides this, the need-assessment interviews and discussions also made me aware of the practices and perceptions of participant teachers. My personal planning was guided by the classroom practices of my M. Phil. study and the research papers which I had gone through. Before joining the context, I had discussed my plan with my friends, facilitators, and supervisor. But when I reach the context and start to collaborate my knowledge and earlier discussions with my university connections were found insufficient. The ideas and theories which we discussed in our classroom settings were found insufficient to justice the real-world context. Noraini (2010) suggests that through the implementation of action research, teachers can gain a better understanding of their practices and make improvements to them.

To enhance their pedagogical practices through transformative learning I tried my level best for the collaborations with the participants in this study. In shifting the paradigm of their practices; 'one-size-fits-all' and imposing so-called absolute knowledge to the students' heads; this study planned a constructivist approach where students can learn from their experiences. We believe that every student is "an active initiator and reactor" towards his/her environment and can learn from there (Marsh, 2000, p. 215). The transformative teaching and learning perspectives that I developed during my masters and M. Phil. Studies as a mathematics facilitator and STEAM practitioner drove me to collaborate with the participants and researchers in designing

and planning a complete scene for this study. To fulfill my purpose of this study I started to collaborate and negotiate with the context.

Planning in Collaboration with Context

It was any day at the start of May 2022. The country was celebrating the season of the local election. I was scrolling Facebook on my mobile in a tea shop around the university area. The three people at the table next to me were arguing and advocating for the candidates for the election and parties. (*Oli ba is the best… no, no Maoist is the revolutionary one… Congress could be the best option for now…)*

The walls of my Facebook were also full of posters of different candidates. Among them, the major posts were for the independent candidate of the Kathmandu metropolitan city.

Though the scenario was election flavored, my mind was stuck with my supervisor's statement which he had told me before two hours.

"*If you cannot remain stuck to your plan then what's the use of making plans, is this your 5 years plan? Now we are giving enough support for you but where are you lost, we don't have our all time for you*; *start your plan fast in the same school where you had worked*" This dialog struck directly in my mind and made me rethink my plan. Then I made a call to the principal of the respective school. The call goes like this:

Me: Hello sir, Namaste
Principal: Namaste sir, how are you?
Me: All is well sir, I need your suggestion, sir,
Principal: Please share,
Me: I am planning to conduct action research for my M. Phil. Dissertation. I am thinking of conducting research in our own school. What shall I do sir?
Principal: Sure sir, let's meet in the school office tomorrow and we will further discuss this.
Me: Sure, sir, I will come and discuss it accordingly.

"Dai chya seto ki kalo?" (do you prefer milk tea or black tea brother?) the sound of the waiter of that tea shop broke my attention. I replied, "*bhai seto leu*" (bring milk tea).

This is how I initially approached the targeted school. The notion of PAR that advocates for the collaboration between the researcher and his/her participants starts with this. The next day, I went to school, and we had a short meeting on this issue. He agreed with my plan and forwarded this issue to the coordinator's desk. I talked to the coordinator then he called the subject teachers (Social and English) in his office. He was a science teacher so I got three participants to discuss my issue on that day.

I shared my purpose and plan with all three of them. They were stocking on my face when I was talking about STEAM pedagogy and the integrated approach for the secondary level. The coordinator seems quite familiar with my talk because I used to share my learning experiences and my university practices with him in earlier days as well, but the remaining two teachers seem confused. Then we decided to plan for a teachers' training program. After a meeting with the principal and teaching staff, the coordinator gave me permission for the two sessions each after the school schedule on Friday.

Taking Workshops as a Way Out

After a short meeting with the participant teachers, I approached each teacher individually and tried to make them familiar with the approach I was trying to implement along with them. I was with the English teacher on the balcony of the first floor of the school building.

Sir, what does this STEAM approach mean?

I listened to this for the first time today with you in the meeting.

I know STEAM means water vapor. How can this be an approach?

Is it possible to integrate the subjects into the higher level?

I have learned about bahubisayagat sikayi (multi-disciplinary learning) in my teacher's license preparation book.

I think this approach is only applicable in lower Grades.

What are we trying to do in this plan?

Sir, "malai chai hajurle bises guide garnu parxaa hai, aafulai ta yesto kehi taha xaena!"[Translation: I need your special guidance as I am a novice in this area]

This is how the English teacher was expressing his feelings toward me on that day. He reflects a similar idea in his reflection paper as well where he has written: "*The terminology STEAM has been misunderstood in the beginning. I still feel ashamed that I thought it was water vapor and some activity related to water conservation. Soon I came to know about the STEAM approach to Educating students*". We talked for a few minutes, and I made him convinced that he is not alone in this plan and that we are going to work together. Further, I made him clear that we are going to conduct a few training sessions for the teacher which the coordinator sir will plan and let you know. His facial expression seems that he was convinced.

Figure 5.1

Teachers participating in group work

The bell rang.

Excuse me, sir. Now, I need to go to Grade VII. We may discuss this further in our next meeting. (He said)

Sure sir. We will meet very soon. I will contact you on Facebook messenger tonight. Good day sir…

Sure sir. Thank you!

I left school on that day. I got a call from the coordinator after two days. He informed me that the training is scheduled for the two upcoming Fridays after the school schedule. Further, he added that the new mathematics teacher (who joined this school last month) also wants to participate in my plan. In addition, he requests me to conduct this training program for all the teaching staff in the school. I agreed with his request and started to prepare for the training program. I, along with one of my classmates in MPhil had prepared a two-hour session for the first Friday (6 May 2022).

We reached there one hour before the training schedule for the setup and other planning. We were provided a hall in the pre-primary block. All the required materials like chart papers, markers, color papers, and A4 size papers were ready in the reception section as per our request. I collected all the materials and reached the training hall. The training started fifteen minutes later than the scheduled time but their patients and enough engagement in the task provided helped us to end it in the pre-scheduled time. The hall was large enough to conduct the program, but it was quite hot as it contains only two windows on the same side of the room. Most of us were sweating at the beginning but they arranged two stand fans which made us comfortable to conduct the session.

Figure 5.2

Wondering for innovative pedagogy

The session starts with some provocative questions like; what is learning? What is teaching? What is the curriculum? And so on…

Figure 5.3

Example of the multi-disciplinary approach

After a short introductory program and discussion on some slides like ways of teaching/ learning/curriculum practices and integrated practices, the teachers were divided into 4 groups; each group containing 4 to 5 teachers for the activity. The figure above (fig: 5.1) also shows how teachers were engaged in the activities and presented their work in front of the others. The figure contains four different pictures of the same setting. In two of the pictures below; the teachers are working in groups; they were trying to connect a theme with STEAM approaches (different disciplines like in Fig: 5.3). In one picture the training facilitator is observing the participants' work and one picture contains the teachers' presentation of their work in front of the groups. The word STEAM as a water vapor was not new for them but the approach to STEAM was new for the majority of the teachers. We

started with their classroom practices and tried to connect them to the different aspects of the STEAM approach. The collaboration in each group, their presentations, and critical reflections for other groups and within the group makes them aware of what they were doing. They seem happy in this setting as they all were engaged in some tasks throughout the session. The participation of the school principal along with the chairman and coordinator makes the session more joyful and productive. All the teachers had given their critical feedback and expectations for the next session. The session ends with this.

Sir, the session was wonderful.

I like this session and the approach discussed over here.

I was also trying to make my class more engaging and constructivist.

Is it possible for me to join in your work?

I also want to learn how this STEAM works and how I can make my students more engaging in my classes.

I think the next session might be more insightful for me…

Those statements were of one participant teacher (Computer Teacher) participating in the workshop. His interest in STEAM practices and integrated approach added energy to my work and motivation. I replied, "*sure sir, let's work together on this project*". He was happy when I showed agreement with his interest. Other teachers also shared their reflections on participation. Few were saying; "*we were thinking like you are going to deliver the contents from your side and we just need to listen. We thought that this session would bring but it is different from our expectations*". As an ex-teacher of that school, I can also reflect that we used to have some training sessions and teachers' orientation programs. A so-called expert used to be there who used to deliver his/her content and motivational speech the whole day. We just need to listen. Though they used to distribute a pen and a diary; I rarely found something to write from those sessions at that time. Around the end of the session, they used to have a game that was only the center of attraction for the majority of us. They replied that such short and engaging sessions where they could perform something made them learn more as compared to the earlier sessions. Those responses from the teachers side made me very happy.

Congratulations Sandip Dhungana (I congratulated myself in my heart)

Hahahaha… It was a wow moment for me.

It was almost 5:35 pm and we (me and my classmate) were supposed to leave from there. We asked for leave with the principal and other administrative members and with the participant teachers. Then we left the school for that day.

Bye sir… Bye mam…

Bye to all…

It was the first session for the teachers in the targeted school. The above scene clearly shows the picture of that event. The transformative notion of this workshop was a novice idea and innovative practice for the majority of the participants. As a transformative learner and a practitioner, I believe that Transformative learning is "a deep, structural shift in basic premises of thought, feelings, and actions" (Transformative Learning Centre, 2004).

In challenging their deep-seated beliefs/practice my intervention could be a mile-stone but I was not sure about its impact on the teachers. Though it was a workshop and we all engaged ourselves in designing the STEAM projects. A few questions were roaming in my mind from the beginning. Are the teachers ready for the new pedagogical approach? Are they willing to modify what they are doing? Will I be able to challenge their status quo? How can I develop teachers to critically reflect on their own practices?

As Jack Mezirow (1997) pointed that the transformation affects our frame of reference of looking towards the world (phenomena) and redefines the context with the new experiences aligned with the existing one. According to Freire (1970), education can only be truly empowering if the teacher adopts a democratic approach and cultivates a transformative relationship with the students, their learning, and society as a whole. For Freire, education extends beyond the classroom and impacts all aspects of a student's life. To transform means to go beyond or across structure; to change completely, essentially composition, or structure; or a metamorphosis (Scott 2006). In this regard, critical self-reflections on sociocultural practices, assumptions through a disorienting dilemma, and exploration of options for new roles, relationships, and actions, as argued by Mezirow (1991) guided me to emancipate the teachers in their role during this study. It was not that easy for me to empower the participant teachers in implementing STEAM pedagogy because of their reluctant behaviors in the earlier stage besides the workshop time. Though they were not happy with the student performance and what they were doing but in the other hand they

were less prepared for the change in their pedagogical practices. It might be because it demanded time and effort to some extent in the initial time.

Practical Yet Technical Class: Teaching for Reproduction

PAR depends on genuine involvement, which entails a cyclical process of planning, implementing, observing systematically, reflecting, and then repeating the cycle by re-planning. There were two cycles in this research plan, and we successfully completed both. We (I and the participants) immersed ourselves to make our plan participatory and engage students in the holistic picture of different disciplinary subjects. We all tried to engage the students to create something new and critically reflect on their actions. Most of the projects were based on the activities through which they can justice the objective of that project.

Though we advocate holistic development and knowledge creation in the STEAM approach. I found that some of the projects (especially in science) were conducted under structured experiments guided by a teacher or a guidebook and repeated the same activity multiple times. I have seen a science teacher with the students in the lab where he was performing some experiments. He does have an experiment book but today he was not looking at it. He was burning Mg (Magnesium) in the air to get MgO (magnesium oxide). I have observed one more experiment where students were around him and observing what he was doing. He was experimenting and all the students were looking at it. Is it the learning that we were advocating for? Do the students learn enough from what they observe? Isn't it necessary to involve the students themselves in such action?

I questioned myself at first then with the science teacher separately in his office. I tried to know why he was doing so. He easily replied that we are not well equipped in our lab and have limited sources. On the other hand, students are also not enough aware to use the laboratory materials like acids, fire, and other chemicals. If they got an accident then their parents will complain and if they misuse any devices or material then that is a loss for the school. "*Then why are you charging them for the study if you cannot compensate for the loss? School is not buying all this themselves but from the students' fee. You have to make them learn from their own experiences.*" I thought inside me but didn't tell anything to him at that moment. I just smiled and left from there.

We discussed it in our group meeting. He was convinced by us in engaging the students themselves, but I was not sure that he is going to do that. I was working with

5 participants in this project but the whole teaching staff in this school was trying to implement this as their teaching-learning approach. My conversation and discussion in the meetings also show that the majority of the teachers believe that engaging the students in any activity is enough for innovative teaching styles. Engagement inside the classroom refers to the 2/3 questions that the teacher asks at the end of the period. One teacher from the basic level was expressing her frustration with me:

> *Sir, I always ask the students about their difficulties.*
>
> *I encourage them to participate in the class and request them to share what they don't know.*
>
> *But the thing is they don't ask anything. I know that they have not got everything, and the face of a few students shows that they don't have got the point but they prefer to remain silent.*

I listened to her then I request her to permit me to observe her class. The next day I was inside her class. She was teaching science subjects in Grade IV. She was teaching whatever was there in the book. She was teaching happily but at the same time, she entered from the gap between the second and third bench; pulled the lobule of the ear of a boy, and gave one slap. Later, I found that the boy was playing with his geometry box and not giving attention to the teacher. The class was pin-drop silent and the one who was shouting was only the teacher. After describing each paragraph, she was shouting.

> *Have you understood? Understood? Understood? If you have not understood anything, you can ask. Ask… ask…*

Listening to her 'understood and ask' inside the classroom, I was getting irritated, how those innocents are enjoying the classes? How can they ask any questions of her as some minutes back their friend was slapped by her? Her nature seems very strict, and I found that the majority of the lower Grade students are frightened of her even without attempting anything wrong. There is no doubt that she delivers the content very well, but I found she is guided by a traditional teacher-centric approach. She prefers silent classrooms and so-called obedient students who remain silently inside the classrooms and focus only on their studies. She even doesn't let her students play on the ground before school time and during the breaks. From her point of view, the reason behind this is the concrete playground and students may get hurt if they fall down. Her logic was not wrong but if a student falls one day and got

small hurt then also no one will get a chance to play for a long time. But she was in favor of playing under the supervision of any teacher.

This case might not be a single case in our schools, but the majority of the teachers might be guided by this approach. I was also a similar kind of teacher before joining KU which I had discussed in Chapter IV as my autoethnographic stories. Teachers here are trying to integrate the practical aspects in their classes with some activities, but I found those activities are also well structured and framed under the rules which promote the notion of 'teaching as reproduction' as argued by Schubert (1984). I found that subjects like science seem quite technical in our school practices because of the less awareness of the teachers in multi-dimension perspectives.

Another incident of the secondary teacher (not from the participant) also catches my interest in him. He is one of the founder teachers of the targeted school and has been teaching accounts and population for a long time. It was any day during the first cycle; I was walking by the TV room and found that Grade IX students were watching TV. The door was closed so I slowly pushed it and saw that students were watching a movie (a Bollywood movie: Three Idiots). I sat with the students for 5 minutes watching the movie and left from there. I found the teacher sitting in his office with a cup of tea. Acting unknown, I asked him:

Sir, are you in your leisure time?

No, sir. Today I have taken my students to the ICT room. They are watching TV. Now, I am also a progressive teacher.

I don't deny that 'students can learn from movies also'. But in the name of ICT integration students are watching movies during class hours. In this situation, the meaning of progressive education and innovative pedagogical practices also differ from teacher to teacher. This is only a case, but such cases are common in our classrooms. Being a teacher, educator, and researcher, I realized the lack of teacher education and TPD of progressive pedagogies in our teachers.

The notion of the STEAM approach could be a way to establish progressive thoughts and innovative ideas in our teachers. Such contribution can enrich the transformative thoughts and practices in our educational system. According to Mezirow (1991), transformative learning can be viewed as "an enhanced level of awareness of the context of one's beliefs and feelings, a critique of one's assumptions, and particularly premises, and an assessment of alternative perspectives". But the scenario I faced in the PAR context was not like this. Teaches were found progressive

in their words/speeches but remained stuck in their conventional practices in reality. It might be better to show or demonstrate what they are teaching rather than just inform. But it might not be enough in transformative practices because students are still passive observers and not getting enough space to engage in the learning process. As this approach is "evolved to address the critical demand for creative transdisciplinary teaching" (Quigley, Herro, Shekell, Cian, & Jacques, 2020) the misinterpretations of the meaning of progressive teaching and learning in the participant teachers were addressed through the intervention.

In this implementation of the action-plan, we have welcomed input from the students as well to present critical ideas for discussion so that teachers can "affirm themselves without thereby disaffirming their students" (Freire & Faundez, 1989, p. 34). I believe that action research is the process of teachers' examining their teaching practices through critical reflexivity which embeds the notion of transformation in them (Burns, 2014). Such critical practices help the teachers modify their perceptions and skills as per the need of time ad context. It most especially leads to positive educational outcomes for students such as improved academic performance, promotion of positive behavior and values, and enhancement of life and survival skills (Burns, 2011; Dick, 2006; Taylor & Medina, 2011). I found that professional teachers' identity is transformed by the teachers' actions (Colliander, 2019) and our experiences, fundamental shift in the sense of our identity focuses on the way of being in the world (Baldwin, 2019). Kitchenham (2008) states that emancipatory learning, from the Habermassian perspective, is self-reflective as the learner gains self-awareness through introspection. The teacher who contemplates their belief regarding the integration of technology in their educational systems and schools, and gains insight into when, why, and what to incorporate, will encounter the process of emancipatory learning. In this scenario to transform the pedagogical practices using innovative pedagogies which can address the need of the learners, the teacher needs empowerment for emancipation.

Chapter Summary

In this chapter (Chapter V) I have presented the initial phase of this PAR study. In doing this I have reflected on my need assessment interview at first. Then I reflected on my planning for the PAR and the workshops we conducted at the beginning of this study. I have also constructed this chapter as a planning of the theory re-building process in this study through meta-perspectives and initiations. The

initiations were taken from the lens of social constructivism where we immerse ourselves in the collaborative process for a common goal and at the same time we critically reflect on our own practices for our transformation in this process.

It was looking a bit easier for all of us in the starting, where participant teachers were enjoying the process but as time passes and they were working on themselves, I found the conflict between their existing beliefs/practices upon the current beliefs/practices. I was known and aware of this happening because they were in the basic state of transformation– disorienting dilemma. Gradually we were serving the common goal for this study and the scene we faced after this is portrayed in the upcoming chapters.

Now it is the time to know how I collaborate and negotiate with the teachers, students, and context. In addition, I have discussed how I felt about the PAR context as avoider in this chapter.

CHAPTER VI
ENHANCING COLLABORATION AND NEGOTIATION ON PAR

Chapter Overview

This chapter starts with the theme *Collaboration in Implementing STEAM Pedagogy, followed by Negotiation in Implementing STEAM Pedagogy, and ends with Avoiders in Implementing STEAM Pedagogy*. This chapter sets a scene for how I delve into the field of this PAR study. This chapter can answer the sub-question (b) of the second research question which was *How did the PAR team-initiate collaborations and negotiations for the STEAM implementation? And, despite the hopeful perspectival transformation, how did the team experience manifold messiness while implementing it?*

The authors like Morales (2016) noted that "PAR has key components: 1) a focus on change, 2) context-specific, 3) emphasis on collaboration, 4) a cyclical process, 5) liberatory, 6) PAR is not just another method, and 7) success is some personal or collective change" (p. 159). The experience I/we gained from this intervention/study is articulated in this chapter and onwards. In articulating this chapter, I have presented the scene, and how I convince and negotiate with different levels of people in the PAR context. The themes – collaboration in implementing STEAM pedagogy, negotiation in implementing STEAM pedagogy, and the avoiders in implementing STEAM pedagogies with their sub-headings are the major concerns in this chapter.

Collaboration in Implementing STEAM Pedagogy

Participatory action research (PAR) is a cooperative endeavor, with those responsible for taking action also playing a role in improving it. The collaboration expands to include as many individuals as possible who are impacted by the practices being evaluated, beyond just those directly involved. Being a researcher conducting PAR in one institution, I tried to collaborate with the teachers, school stakeholders, and students in every possible way. Their participation, suggestions, and critical comments were highly welcomed and addressed in every possible case. Though I was the ex-teacher at that school it was not that easy to collaborate with each of them on this project. Previously I was familiar with them just as their colleague sharing

everyday experiences but this time we are working together to accomplish a targeted work.

Likewise, "We as human beings have created knowledge … continue to create a new knowledge. …knowledge has historicity. That is, knowledge never is static, it's always in the process" (Horton & Freire, 1990, p.194). This advocates that educational practices and pedagogies cannot be isolated from cultural and societal practices, so they need to address societal expectations (Singh, 2012). For this, a school, educator, or facilitator needs to communicate and collaborate with the contemporary practices of the learners' context to modify his/her pedagogical approach. They were supposed to contribute enough support from each of their sides at the beginning.

Collaboration with Teachers

Teachers are the primary participants in this study. Formally and informally, we (me and the co-researchers) sat together in multiple settings. The settings were in-person in the school, virtually on Facebook Messenger, in Google Meet, or chef's house (a restaurant near the school). Those sitting were highly focused on the collaboration activities for the integration of different disciplines in the STEAM projects, the critical reflection of previous plans/projects, and the modification of the earlier plans. "*I along with all teachers sat and discussed how can we follow the collaborative approach in our school in teaching different subjects*" (Social Teacher). Further, "*my co-worker helped me to know the various approaches of teaching and learning theories, pedagogies and innovative ideas for teaching and learning*" argued the science teacher in his reflection. The collaboration with the teachers of different disciplines in the STEAM activity also fosters collaboration with the students. One of the co-researcher teachers (an English teacher) wrote like this in his reflection:

Figure 6.1

Sample picture for the collaboration

> *This week in collaboration with the Social studies teacher, Math teacher, and ICT teacher my students performed a drama on cultural diversity. I was observing the essential component of Language learning. Listening, Reading, Writing, and Speaking. While performing drama, my students used correct sentences without/ very few grammatical errors. I was teaching them poems related to diversity and conducted various debate sessions on it. In these two weeks, I have found that my students have become more outspoken. Normally they hesitate to speak in English, but now they can easily express or write a reflection on it.* (4 July 2022)

His reflection shows that he is much happier with this approach. Though he seems confused with the idea of an integrated approach at the secondary level as I argued in earlier paragraphs; he was questioning himself in his write-up "*What does my school want me to do? Am I teaching them 21st-century skills? I have questions all over my head. I always wanted to do something different in my classroom*". Though all teachers were not together in each meeting what I found was they were not satisfied with what they were doing but at the same time, they were not enough aware of their practices. The blaming game of teachers to students, teachers to parents/school administration, students to teachers, and school administration to the teachers was growing rapidly. The majority of them do not want to accept the lacking from their side but blame others for what is happening there. Among the five participants in this study three of them (Science, Social, and Mathematics teachers) mentioned in their reflection that they were awarded the 'best teacher award' sometime during their service. They are still stuck in that award which they had received ten years back because their students had scored good marks/grades in SLC/SEE examinations.

During the need assessment and in other interactions I found that they had never tried to collaborate with the teachers of any other disciplines to teach any idea from their content area. "*It was my first time working collaboratively and following different teaching approaches inside my classroom*" argued the Math teacher, and further added that "*I found that this new approach to education is more effective for teaching and enhances the learning of students*". On the other hand, the Computer teacher argued, "*Computer programs and programming-related studies can be easily connected with mathematics, the activities which we had collectively designed in*

statistics help me in teaching Excel and QBASIC programs". This is how the collaboration took place. I also joined some lab work in computer class and helped students with Excel work. "*I found such collaborations with different disciplines are not only helpful for the students, but we teachers are also learning from each other*" argued an English teacher in his reflection.

Though I tried to make it enough participatory a few teachers seemed like token (so-called passive) participants.

You are an M. Phil. Scholar in KU.

If you are doing this, then it is effective.

What can I comment/suggest to you? You are a progressive teacher.

Sir, you can make it. I have full support.

This is a nice project, sir! I don't have any observations. (Social study teacher, 5 June 2022)

Such type responses from two of the teachers in the earlier days showed their less participation. "*Because of less time and pressure to complete the course along with trying and practicing some approaches of the STEAM. I was less able to collaborate with other teachers because of my busy schedules and college*", one of them argued like this in his reflection. The next teacher also revealed in an informal talk that he needed to be with his kids in the evening time and could not give enough space for this project. The scenario shows that it took time to grab the interest of the participant teachers in implementing STEAM-based pedagogy at the secondary level. Probably they might be at the stage of a *disorienting dilemma, self-examination, or critical assessment* as argued by Mezirow (1981). Though they were not reluctant in implementing my plans in their regular classes, their direct participation in preparing those plans was quite challenging.

To meet the diverse need of learners from different cultural backgrounds and to minimize their frustrations towards learning, teachers need to bring variety to approach the students in the classrooms (Singh, 2012). To bring such variety teachers need to create a collaborative environment in their schools. The goal cannot be achieved through a single person's interest or effort in the organization hence collaborative working environment is a culture in any workplace to achieve the common goal (Decuyper, Dochy, & Van den Bossche, 2010). Mezirow (2003) also advocates that "Communicative learning… involves understanding values, ideals, feelings, and normative concepts about freedom, autonomy, love, justice, goodness,

responsibility, wisdom, and beauty" (p. 59). We as participants were also exploring and learning something new in a group to enhance our professional skills which can contribute to the holistic development of the learners. I was looking for multiple levels of collaboration and communication for the teachers in this intervention; teacher-teacher collaboration, teacher-community collaborations, teacher-student collaborations, teacher-researcher collaborations, and so on. I had exercised a lot in the earlier days to bring them together in a single project but later when they were convinced and experienced that an integrated approach is feasible at the secondary level and can contribute to both teachers' and students' learning then they engage actively with me.

Collaboration with Context

The context here refers to the school's stakeholders, administrative members, and the school premises. I have considered the school context as a secondary participant in this study (See Chapter III). In collaborating with this context, firstly, I approached the principal as I discussed above, and then with the remaining people. I can remember his concern about the course for the first time when I approached him, "*Sir, course ta agadi badxa ni?*" (sir, will the course go smoothly?). He was worried whether this pedagogy may delay the course or teachers might be misled or lost with the innovative approach. But it does not take much time for me to convince the principal because he was also in favor of innovative ideas in educational practices but was not able to implement them in his school.

Further, I collaborated with the school management (coordinator) to manage at least one ICT room. This was not my single advocacy but the computer teacher and the social teacher were also demanding such a room to make their class better and computer friendly. Being a researcher and a participant in the same context made me aware of my dual nature. Though I was scanning each moment with them, I participated like an ordinary teacher. The math teacher in that school seems quite fearful in the earlier days of STEAM implementation so he was an observer in my class and I run the class. He mentioned this in his first reflection also and wrote:

> *At that time, I knew about the project but I was unable to collect all the ideas. When we were in the classroom for a project, he took the lead for continuous 4 days, and at that time I gained the idea to imply a STEAM project in the classroom. It was only after the fifth day I took the lead in my class; I had doubts, I didn't know how my students will react, but after observing Sandip*

> *sir's teaching and engagement process I gained confidence. I handled it properly. I found that this new approach to education is more effective for teaching and enhances the learning of students. (10 June 2022)*

I need to collaborate with the context in different phases and levels. Sometimes I need to collaborate with the sports person (coach) of the school to know the sports schedules. Many times, I need to miss classes because of their inter-school basketball competitions. The research school had also conducted an inter-school basketball competition around the end of my field study which delayed my plans for one week more. I realized that it was not that easy to be a researcher, more specifically, a PAR researcher as I had to make other people work in my plans for my benefit. Though I was trying to transform their professional practices; a few of them seemed like they were only doing my task. Once the English teacher told me on the ground at break time; *sir, I am doing your job. Whatever plan you sent last night, I have given them all.*

Then I replied: sir…

This is not only my plan.

This is our plan.

We are doing this to transform ourselves.

We are trying to shift our pedagogical practices.

Don't you think like this?

He replied, yes sir. I am doing our work (he laughed).

During those days, I found that participation and responsible participation can be different. Responsible participation here refers to such participation in which we contribute ourselves to the job from the inner heart. And it was not that easy for me to motivate each of them to participate in my plans though they gave me ample time to contribute to this study. For this collaboration, I figured out how important the role of a team member is. For a teacher to work smoothly and tackle upcoming hurdles the plan, collaborative work, group discussion on classroom issues, students' behavior most importantly teamwork has to be transparent for future good (Powell,1999). Jones and Harris (2012) shared the implication of team teaching and its benefits for teacher and learners hence everyone at school is a part of the team who work together for common purposes anyone's passive engagement can delay or create an obstacle to achieving a common goal.

Collaboration with Students

Along with the context, students are also considered secondary participants in this study (See Chapter III). The targeted groups to implement the common plans were students. Being their math teacher up to last month we (I and the students) were familiar with each other. They were also familiar with project-based learning, and as a pilot test, I had implemented a few plans in their earlier grade. Those plans were prepared as in-semester assignments and I had to collaborate with my classmates at that time. The STEAM project like 'rainwater harvesting' was one example among many and its model was still there in their lab.

I found all the students were very positive about the STEAM implementation. I told the purpose and objectives of my research study to them. Though they were familiar with my teaching approach and with my projects but the integration with the other disciplines of their classes and with the same teacher who is teaching for them was for the first time. All of them had shown their agreement on my purpose; some by speaking, some by shaking heads, and some by giving smiles.

Sir, what is research?

What does it do?

What is the purpose of doing research?

Are you going to teach science, social, English, and computer also?

How will our English and social teacher teach mathematics?

Are you going to teach all these subjects in one period?

(Grade X students, 18 May 2022)

Those questions from the students engaged me for some time with them. I convinced them in the simplest words that they can understand. They seemed excited to learn English, social, and computer through the mathematics contents. These were the initial days of teaching them with the STEAM approach. I was preparing the projects for them. In the first cycle of this plan, I had to prepare the majority of the projects and then send it to the participant teachers for their observations and feedback. Email and Facebook Messenger were the major means of communication with teachers and students. Some students were not familiar with mail, but they learned it by themselves. I found that students nowadays are techno-friendly, and they can easily access tutorial videos on YouTube and learn from there. "*Sir, we can do this, we can learn from YouTube,*" said one of the students. I managed a Facebook messenger group for the participants' teachers and Grade X students. One girl from

the students helped me to add all of her friends to the group. From the initial days of this intervention, I communicated with the students in that virtual group. I used to share the information and sample projects, I used to facilitate their queries. My participants' teachers were also members of that group so that they could also easily access what was going on though we used to have a separate group for the teachers.

As we were implementing STEAM projects to serve the purpose of this study, those projects demanded enough collaboration between the learners in their team to solve complex, time-consuming, and open-ended problems (Powell, Powell & Weenk, 2003). The actual learning happens when the classroom is open to communication. Students have millions of ideas and thoughts and communicating them with other peers and their teachers engages learners actively (Gross & Rutland, 2017). We believe that PBL (Project Based Learning) "involves students actively in their learning" (Alves, van Hattum-Janssen, & Fernandes, 2021, p. 6). As STEAM practitioner teachers, we shared our role with the learners in designing the activities and this shared purpose makes the learners responsible for its execution and extracting knowledge from there.

Collaboration with University Stakeholders

As I am talking about the collaborations in different headings from above which contribute to making this study possible, the University is another major organ in this study. The regular sessions at KU, the contribution of my classmates, and their critical suggestions helped me to refine and modify my projects and plans. The regular supervision of my dissertation supervisor and his inputs added another level of collaboration with the university stakeholders. Apart from this, I communicated with other teachers also in our STEAM department to find the possible integration of mathematics with other disciplines. Hargreaves (2003) wrote "Sharing ideas and expertise providing moral support when dealing with new and difficult challenges, discussing complex individual cases together - this is the essence of strong collegiality and the basis of effective professional community" (p. 109). I have submitted each day's reflection to my supervisor during the execution of the plan and modify accordingly. "*Sandip Ji, it's great; please go ahead, how are you feeling doing this? Is it fruitful in your context?*" Such questions and inspirations always motivated me to make my plans better each time. Self-reflection and critical self-reflection were the means to get resilience in my work. Each bounce back after implementing the projects made me more mature for the next plan. Literature like Falk and Blumenreich (2005),

Alber and Nelson (2002), and Mills (2003) mentioned that classroom research is one way of improving reflectivity and PAR is “heavily depended on the reflective practice of the researchers in action” (Morales, 2016, p. 161). This research is also the action after the reflections on our regular and conventional practices. As a STEAM scholar at university and a researcher/ participant in the research context, I have reflected critically on my actions and the perceptions I was guided.

I have prepared and worked on many projects and activities collaboratively with my colleagues and facilitators as a STEAM scholar which I have implemented in this study. The guiding loops and threats of regular observations and inputs in my work from the university created a strong bond of collaboration. From this study, I realized that “to experience anything is to participate in it, and to participate in it is both to mold and to encounter it (Heron & Reason, 1997, p. 3). We embraced the possible steps and STEAM components in designing our plans for this study and critically reflected in our every action for its improvement.

We understand that such studies (PAR) have an intention of constructing knowledge and bringing social changes or transformations (Lykes, Hershberg & Brabeck, 2011, MacDonald, 2012, and Stoudt, B. G., 2009). We also experienced transformation in our pedagogical practices after this intervention and we even feel succeeded to change the school’s pedagogical practice to some extent. The authors like Sappington, Baker, Gardner, and Pacha (2010) mentioned that PAR can be "a teaching-learning strategy that sharpens the students’ awareness of the gap between existing conditions in schools and prospects for significant improvement" (p. 250).

Negotiation in Implementing STEAM Pedagogy

PAR involves participants and researchers in collaborative processes for generating knowledge. This approach of research integrates values and beliefs that are indigenous to the community into the central core of interventions and outcome variables. Being a transformative researcher adopting PAR as a methodology I am guided by the notions of post-humanism. I found this philosophical point of view is matured from humanity where there is no supremacy and give equal emphasis to non-human existence also. As a researcher and a participant at the same time in this study, I negotiated with the teachers, students, and the context in different phases and levels.

As a scholar at KU, I have learned and made one level of understanding of STEAM pedagogy and integrated approach. Though we had discussed and practiced connecting one subject to others in our training sessions and informal settings. They

requested me to make some sample projects to implement then they will initiate afterward. They used to give feedback on my plan, and I used to modify that. I found that where there is collaboration there come negotiations. And higher the collaborations and collaborators the degree of negotiation also rises significantly. Many times, I changed or modified my assumptions and plans.

In addition, I realized that reading journal articles and working with classmates who are facilitated by the same facilitator is different from the real-life scenario. To work in a real context as a researcher is a more difficult task than working with people in hypothetical settings. In serving the purpose of this study, I faced different types of challenges in the research context, and I needed to negotiate at different levels. Some of my challenges were similar to the challenges faced by Nelson (2014) in PAR which "include fears of participants, stresses of everyday life, tensions between commitment/involvement in the project and priorities of participants and the workplace, geographical distance between researcher and participants and between participants, anything that might impinge on participants' ability to collaborate and engage meaningfully in the process" (p. 13-14). After the completion of each plan/cycle, we followed three Es (Experiencing, Enquiring, and Examining) models for the self and critical self-reflection. In doing this, I had to negotiate at different levels which I have discussed below:

Negotiation with Teachers

As I argued earlier that teachers are the primary participants in this study. I had to negotiate with them in each setting, sometimes to modify the plan and sometimes to make them comfortable. To preserve the notion of PAR i.e., participants as competent and reflexive agents capable of participating in all aspects of the research process, I have involved the participant teachers in all possible aspects as far as possible as collaborators.

Figure 6.2

A slide from the student's presentation

Sandip sir, today I am not able to attend the meeting in the evening time.

Today I am in a tuition class, you guys can carry on.

Please circulate the plan, I will look at it later.

Can you manage a separate meeting for me in … time?

Sir, today I have urgent work outside, can you please manage my class?

Tomorrow I am planning to take a test; I won't be able to follow the plans for 2 days.

Such statements from the teachers frequently struck me and I negotiated with them on each level. One of the themes in our plan was social media where I connected statistics with mathematics. We had prepared the plan with our collective effort. I had a sample plan for this which I shared with them on the Facebook Messenger (FM) group two days earlier then we sat together to finalize it. The questions in the plan were like this:

……
…… *(A complete sample plan is attached in the appendix)*

(i) Find the average time, median, modal class, and quartiles from the collected data information.

(ii) Write a poem about the use of social media in the classroom (you may use the data—surveyed or other sources).

(iii) Write an essay on the use of social media among your grade students of your school at home aligned with your surveyed data.

(iv) Develop a one-page debate—against and for the use of social media in learning

(v) Use the information available (you may explore in various sources); relate to other school students thereby the scenario of the world.

(vi) Write brief conclusions highlighting opportunities and challenges created by social media in the study.

(vii) Construct Pie-Chart, Histogram, and line graph and explore more charts in excel.

(viii) Create documentation of the above task in MS Word (if it is not feasible for you, then you can create it manually.

(ix) Write a QBASIC program to find the mean, median, and Quartile.

(x) Create a PowerPoint slide of the above task which you need to present in the class.

(xi) Make a recommendation.

(xii) Submit the report.

This was a sample format for statistics where students were supposed to take the survey from the students of different classes. Students were divided into five

different groups and each group was supposed to collect the data of specific classes. My intention behind these questions to be here is to show the negotiation with different teachers at a time. This project was the collective plan of the participants' teachers of English, Mathematics, Social Studies, and Computers. Apart from this, I had to negotiate with the coordinator and the class teachers of other classes to permit my students to collect the information from their classes. I had to convince the teachers that the collected information will not be misused. Sometimes students took some extra time in the lab work and activities then I had to negotiate with the teacher of the next class. The researchers like Kemmis and McTaggart (2007) suggest one of the distinctive features of PAR is a reflexive process through which individuals can "transform their practices through a spiral of cycles of critical and self-critical action and reflection" (p. 282) and I experienced such transformations demands a lot of time and effort. Sometimes I even felt like participants in this study might consider this approach as "predominantly grounded in Western assumptions and cultural values" (p. 626) and may not cope in our context. In such a scenario, their values, and assumptions were critically challenged, and engaged in problem-solving actions for their transformation from technical interest to practical interest, and practical to emancipatory interest as argued by Habermas.

Negotiation with Students

Students: the secondary participants in this study.

Students: the heart of the school

Students: the audience for the teachers

Students: the powerful force in a school

My experience of teaching different schools in the different contexts of Nepal shows that 'students are the powerful force in any school'. If a teacher wants to remain to teach in any school, he/she needs to make the students happy. I can remember my school days as well when teachers used to come for the demonstration cases before they joined teaching in that particular institution. The principal/vice-principal/coordinator used to sit in the demo class and later used to take our reflections. There was democratic access while keeping any teacher and nowadays also it is in practice. I was also in dilemma whether students are going to welcome this approach or not! I was very transparent with my plans and purpose of the study with the school, teachers, and students, which made it quite easy to convince them. In the beginning, the majority of them were not very sure what we were going to do but

they showed their agreement with the new pedagogical practices. I needed to convince and make the students happy to implement the plan. This was my first negotiation with the students.

Secondly, I negotiated with them on a few contents like poems, songs, and dances. There were provisions to write poems, songs, and need to dance in some projects. I found a few students were reluctant about this. Though I always encouraged them to participate in all activities, but I didn't force them in any.

Sir, I cannot write a poem. May I write an essay instead of this?

Sir, it is difficult to write a song…

Sir, I feel shy to dance. I have never danced.

Sir, today we want to play basketball.

Sir, we rarely go out of the school, let's go for the field visit within these planning days.

Sir, can we go to the TV room and continue this chapter from the YouTube videos?

Sir, can you please talk with the principal sir for at least 3 classes for game periods in a week?

Children are innocent. They are happy with small/small stuff, and I believe that an individual can be learned better in a happy mood than in a sad mood. Being a teacher, I found that a happily engaged student can learn and understand better than a student engaged by force. This belief encouraged me to have negotiations with students at different levels.

Figure 6.3

A boy making his project

Dear students,

I am happy to know your demands and wishes in this concern. I am never against your wish, but the thing is, we have to cover these lessons and activities within this day/week. If you can cover the targeted work in time, then I am ready to talk to the coordinator sir, and other teachers regarding this. Let's finish this first then we will go with your plan.

Okay... sir... (they used to take a long voice)

We have tried to make the classes democratic enough for the students. Their voices were heard as far as possible because of which students were also actively engaged in the given task. "*I have found that my students have become more outspoken*" argued an English teacher. "*Nowadays students are speaking without hesitation and are involved in the activities happily. I found that low-achiever students are also trying to do something new. I think this approach is working."* The math teacher was arguing in his reflection.

Students were learning from their own experiences, and we experienced that working with other teachers made it easier for students to learn and relate. (Winkler et al., 2015) stated that experiential learning can be included in school curricula where it harmonizes educational objectives and content knowledge to all subjects. In some activities, they need to prepare some materials. They were engaged in individual and group work on STEAM projects. Some of them had prepared it in the given time, in leisure classes, and some in break time as well. I captured the picture (fig: 6.3) when one student was trying to complete his task by sitting on the stairs in his leisure time.

Such engagement from the student side and their rigorous effort sometimes made me emotional. In doing this we were guided by Kolb's (1984) experiential cycle which includes four segments "concrete experience, reflective observation, abstract conceptualization, and active experimentation" (Flynn, Stephens, Cunningham, & Burke, 2021). Learning is a continuous process and can be modified time and again through collaboration and does not end with specific outcomes (Kolb, 1984). Such real-world practices in education make the students realize that "the school plays a fundamental role in the improvement of individuals and is capable of providing solutions to the problems of today's societies" (Gavari-Starkie, Espinosa-Gutiérrez, & Lucini-Baquero, 2022, p. 6). However, "Simply inserting experiential activities into teaching without providing a consistent experiential pedagogical framework diminishes success for learners" (Blair, 2016, p. 5). So we were very conscious and aware of the approach we were adopting for this study. I was ready to negotiate with their plans and wishes because they were also in my plans.

As secondary participants in this study, we were having enough collaborations and negotiations with the students. Their interests were always on priority which helped us to reduce their anxiety towards learning and able to empower them in the learning process. The result of this practice can be easily extracted from the smile of

the boy with his handmade material at the side. Their creations and innovative ideas were presented in a small exhibition.

Negotiation with Context

PAR allows and requires participants to build records of their improvements and changes in their personal and professional assumptions and practices. They must be able to demonstrate their learning with the evidence of their experiences in implementing the PAR cycle. In this scenario for the development of transformative practices and hybridizing the pedagogical practice of the researched school, we negotiate with the context. The context here refers to the settings of the school, stakeholders, community people, and all the remaining factors that contribute to this study besides the research participants.

There were some changes in the regular settings of the school. Initially, there was no STEAM lab in the school, so we used to conduct our activity on the stage area or the ground. The school department felt the necessity of the STEAM lab for the students' better learning and with the coordination between the school department and participants, we were able to make it true. Though it was less equipped in general but enough for us to conduct our activity.

Now we can count our school also a progressive school.

This lab may contribute to learning practically.

Thank you, Sandip sir.

We were always in favor of this, but we used to think of this as a sophisticated idea and not affordable for us.

Now, you have to encourage the other teachers at our school also in this collaborative practice.

The principal sir was sharing his happiness with me in the STEAM lab. *Yes sir. This is not that costly for us, but it is just the beginning we can manage many other types of equipment also. Continuously this lab will get upgraded. Now we are trying to place the materials which we are preparing on our own.* I replied to him. *Sure sir… (He responds)*

Sir, we are renovating the computer lab as well. He added.

The computer lab was next to the STEAM lab. This lab had already been there for many years, but the computers and the furniture were very old. It was not only me who requested its renovation, but the computer teacher was giving pressure on the school since last year. This might be a co-incident, or the school might realize its

importance; nearly 25% of old computers were replaced and Mr. Darnal (computer operator) was fixing the remaining unused ones also. Sharma Ji (carpenter) was busy fixing the old furniture and making some new ones. I felt like the school might have managed to accomplish our plans because it happened during my research time. *Hahahaha… I feel lucky that the context is in my favor.*

There was already a big TV (Television) in the TV room, but it was not feasible enough for the presentation and other ICT-related activities. The TV room was usually busy with rhymes and cartoons for toddlers and kids. The senior classes rarely got a chance to enter this room, so ICT-related activities nearly faded. To overcome this scenario, we discussed it in our group and then discussed it with the principal. He was convinced of us. He requested me to go with another founder to get a projector. Along with this, he told us to bring a color printer. The color printer was already in their plan. On the first Friday of the plan implementation, we got both electronic devices in the school.

Similarly, another level of negotiation was with the community practices. The projects in social studies and mathematics may require some data from community members, governmental offices, and officials. For this, we need to negotiate with community practices. During this research plan, we had a negotiation with a plant nursery near the school. One of the founders had managed this for us. Two of us (I and the science teacher) visited the plantation area with Grade IX and X students. The purpose of this visit was to explore flowering/ non-flowering plants, pollination, and other related ideas in science. I requested the students to explore the area and shape of the gardening field. They submitted their reflection and mentioned their learning from this visit after 2 days. The reflective writing of the field visit is in the social study curriculum at the secondary level.

Active participation of the learners can be seen in experiential learning (Vinagre, 2017). Student-centered experiential learning is gaining worldwide popularity in the 21st century (Slavich & Zimbardo, 2012) and educators around the globe are experimenting with its different components like problem-based learning (Gurpinar, Bati & Tetik, 2011); Bethell & Morgan 2011). To create such activities and to engage the students in the learning process we dealt with the principal of the school at first and then he initiated us into the community base. Experiential learning provides students with tools to experience the natural phenomena of the surroundings and relate them and bridge the gap between theoretical and practical knowledge

(Wilson et al., 2018). In the classroom, learners acquire knowledge from various sources but application of the gained knowledge to the real world helps learners to have deeper understanding and enhances their critical thinking, communication, and problem-solving skills too. (Leung and Cheng, 2019).

The Avoiders in Implementing STEAM Pedagogy

The notion of the PAR study is to engage the participants in a common goal and find possible solutions to common problems. I have also worked collaboratively with five different teachers of different disciplines to meet the objective of this study. In doing this I have also faced many avoiding activities in the context in which tried to be reluctant in my act. Though it was not that easy to break the conventional status quo of the teachers, I have portrayed my experiences in working in the field of this study in the sub-headings below.

Avoiding Teachers

Don't just reflect. It would be far better if improvements came along with reflection.

I have heard this statement many times in the session by Prof. Luitel in our classes. Our discussion on the research articles and reflective assignments made me aware of my practices but this awareness was found quite superficial from my perspective. Superficial in the sense, I was advocating based on the research articles and others' practices but not experienced in my own. In this PAR study, I got an experience of the real-world scenario of working in collaboration with the teachers from different disciplines (like science, math, social, computer, and English) in my context. Collaboration with teachers of multiple disciplines in school is not new but we used to collaborate only on the non-academic sides like in programs, functions, and other school activities. It was the first time for all of us that we were collaborating with each other in designing teaching/learning projects and activities that can be addressed the holistic development of any learner. Such an integrated approach guided by STEAM pedagogy makes me aware of the reluctant factors of teachers in participation.

It might not be a new thing that human nature tries to remain in its own comfort zone and is less willing to take a risk for changes. Though all the participant teachers were willing to be a part of and want to contribute to this intervention as they told during the training session:

Sir, I am really excited to be a part of this study.

I think this approach can address the need of our students.

I might engage my students in the activities.
I might get a chance to learn how to design projects and its implication part.

These were the statements of the participant teachers after the training workshops which were organized on the STEAM curriculum and its practices. We all were excited about designing the STEAM projects and implementing them, but the excitement did not last long in the case of each teacher. Avoiding group work and meetings was common for a few teachers in the first cycle. Though they were in support of this intervention, they might have avoided their participation because of their domestic work. Usually, we use to conduct our meetings and reflection sessions at night but a few of them used to miss it because of their family life. I used to take their views, ideas, and concerns orally during the daytime and used to address them myself. Some scenarios like:

Sir, the exam is near, and we need to make our students memorize the content areas. If they get fewer grades/marks, then their parents will complain. It is very difficult to convince parents at the senior level. Let's focus on Grades. (English teacher and Math teacher)

This was not an unexpected statement for me as I was also brought up in the same context following a similar kind of set of beliefs. I didn't deny their opinion also but requested them to go side by side and we had a different form of revision classes this time than before. We revised the lessons with STEAM perspectives and teachers were conducting question/answer sessions during the activities as well. It was quite difficult for me as a researcher and a participant teacher to engage the remaining participants in designing the task and to reflect critically after the complication of each task. Some teachers used to write their experiences in Google Docs, where some in Facebook Messenger, and some used to tell verbally during the break/leisure time which I had collected in my notebook. They (participating teachers) had also realized that some students were not familiar with what we were doing for them at the beginning and critical self-reflections make them more aware of it.

The second cycle was comparatively easy and fruitful for the transformation of the teachers as they all were collaborating with each other in their teaching practices, at least with the teachers of two other disciplines. The sudden shift in teaching practice and engagement of different subject teachers to adapt to new scenarios might be challenging in the beginning however commitment towards work and hearing each other's voices can bring expected results in the future. For this, the

classroom has to be democratic where students are given a sense of belongingness and autonomy (Singh, 2012). We know that real-world practices and issues are never compartmentalized from one lens or a single subject like discipline rather they appear in holistic pictures. At this point I found, linking the subjects with each other which can set a holistic picture for the learning environment might be decisive in educational practices.

In this scenario, the integrated STEAM approach creates a space for teachers to educate learners and grasp the ideas of holistic components as well as understand every single discipline and their relation to one another (Vesikivi et al., 2019). Even for my project too, I had discussed with other subject teachers and worked collaboratively. The paradigm shifts from one-disciplinary to multi-disciplinary space is a beauty of Education that brought whole ideas for our learners which is only possible if we go beyond the disciplinary boundaries (Baligar et al., 2018). Further, the author added that teachers' professional development can be enhanced along with learners' academic growth. Planning from the inception level to implementing the ideas in a group has many benefits. But establishing this realization in our teachers is a challenging task. The unseen picture behind those situations might be less familiarity of teachers with the behavior of learning, unlearning, and relearning.

Avoiding Students

As secondary participants, the role of students cannot be denied in implementing STEAM pedagogy in this study. I believe that "participatory action research has not been just a quest for knowledge. It is also a transformation of individual attitudes and values, personality and culture, an altruistic process" (Borda, 2006, p. 32). And for the transformation of the participant teachers in their professional practices, the acceptance of the students in the intervention is needed. In addition, Miller and Brewer (2003, p. 225) also noted that PAR, "aims to produce knowledge and action directly useful to people and also to empower people through the process of constructing and using their own knowledge." In this scenario, being a

Figure 6.4

Metaphorical picture for transformation

teacher and a researcher, I believe that the empowerment of the teachers also depends on the empowerment of the students.

The transformation of teachers and transformations of students need to move side by side in the same direction to accomplish the desired goal. I believe that our current practice and recovery trend are not enough for transformation. We need to go beyond our regular activities and limitations. To cross these boundaries and get enough acceptances in the context both the actors and their audiences need to have common interests. In this regard, students as the audience or the co-constructer of the knowledge along with the teachers need to accept the transformative thoughts. Being a researcher and a participant in this study I experienced different types of avoiders from the students' side in implementing STEAM pedagogy.

Figure 6.5

Metaphorical picture of side-by-side

Not only the literature but also my experience says that the STEAM approach is a student-friendly approach that can address the need and interests of 21st-century learners. But a teacher needs to be aware of the nature and interests of the students before designing any projects. I found that some students (especially boys) are not interested in the activities like singing and dancing, rather they prefer games or any other hands-on activities. Some girls are really interested in dancing and singing and some are not. One day English teacher was revealing his experiences with me:

> *Sir, yesterday I prepared a collaborative plan with the social study teacher where students were supposed to dance in their groups. The song was all about the legislative body in social studies in alignment with English literature. We had discussed dancing pedagogy in our last meeting, and we were trying to implement it. Many students denied dancing which made me feel annoyed.*

Sometimes I feel like we were not able to address students' interests which we reflect on in our meetings then we revised our further plans. Some participants like science and math teachers felt that students were not obeying them and sometimes ignoring their instructions. Whenever I talked with them, they had something to talk

about the students same as this. In those situations, I just smiled and told them that "*Sir these are the phases of transformation*".

As a teacher of the same level and a university student, I reflected critically on my several practices and found that we as a teacher usually have complaints and dissatisfaction with our students. We never reflect on our own practices and never want to accept any type of lacking in our practices. So, to make the participant teachers aware of their practices we sat together frequently and revised our projects and practices time and again. Whenever I sat with the students either in their class or with them in the projects, I found that the majority of them were actively participating in the given task. Few of them were enjoying the work done by their friends and very few were not involved actively. I found the major problem for those few students was the documentation and other writing activities. Because of the documentation and write-up in each project, few students tried to escape their classes in the name of basketball and other sports practices. To address such kinds of problems we teachers integrate role play and dramas in our projects. The mathematics behind the games, its courts, and other activities also attract the students to our projects thereafter. We found the avoider students in the earlier phases of this intervention and the first cycle, but they easily got habituated to the progressive/innovative approach which made our work easy. When the students were able to understand what we were doing for the teaching, the environment was comfortable enough for all the participant teachers to implement what they had planned for them.

The scenario shows that we need to make the audience ready before we act on something. It is not necessary that the benefits from the teacher's perspective match with the benefits from the students' perspectives (Money & Coughlan, 2016). With the joint effort teacher's workload can be minimized (Alves, van Hattum-Janssen, & Fernandes, 2021). They have conducted their research in engineering education in implementing PBL in teachers' collaborations and found that such action needs enough 'communications and agreements for the activity/projects designed and even the teachers need to be very aware of the student's learning process. As a practitioner, we believe that the empowerment of the students is possible only from the 'means' of learning rather than 'ends'. "The challenge for the teacher who believes in student empowerment is to create an environment which is both stimulating and flexible in which students can exercise increasing levels of power reflecting upon and evaluating the new learner-teacher relationship" (Peterson, 2003, pp. 373-374). In addition,

Horton and Freire (1990) argued that as a teacher we need to challenge the deep-seated practices and status quo in educational practices to try something new, “there is no creativity without rupture, without a break from the old, without conflict in which you have to make a decision. I would say there is no human existence without rupture” (p. 38).

Chapter Summary

This is the end of Chapter VI where I presented my experiences and how I drive into my research context. At this moment I realized that working in a group might be a strength to minimize the difficulty but sometimes working in a group can be a difficult task to agree on a common plan. As a PAR researcher, I experienced that we as a human are reluctant to our comfort zone; very few people want to take challenges that can question their current practice. In the beginning, all the co-researchers were very excited to be part of this study, but they showed their reluctance at different points of the intervention. As a transformative practitioner, I found their dilemma a turning point for change. Few of them tried to avoid participation during the study and remained as token participants, though their moral support was always with me. The collaborative work and negotiations between all the co-researchers minimize the avoider’s strength and involved them in the intervention that ignited a spark for transformative change in their professional skills.

Now, this is the time to know the participant transformation through PAR, the harmonious scenario created through STEAM pedagogy, and the sustainability of the teachers’ practices that they along with me had gained from this intervention, which is articulated in the upcoming chapter (Chapter VII).

CHAPTER VII
ENHANCING HARMONY AND TRANSFORMATION WITH SUSTAINABILITY

Chapter Overview

This is chapter VII and the last chapter of data analysis. As I informed in the last section of the previous chapter, this chapter contains how teaching can be joyful for the learners, contextualization of mathematical concepts, ICT integration in classrooms, emotions in mathematics classrooms, the transformation of the teachers, and the sustainability of the practices that they have learned from this intervention. I am using the term harmony in the heading of this chapter which refers to the agreement of the ideas, feelings, or actions, or a pleasing combination of different kinds of thoughts and practices of the PAR team. Transformation here refers to the pedagogical changes they experienced from the PAR intervention, and sustainability refers to its long-term impact on their professional life as a teacher/facilitators. The transformation in the participants' beliefs and practices being a teacher/facilitators and its impact on their professional journey are the major component in this chapter. In addition, this chapter also contains the transformations and sustainability of learners' (students) practices in a harmonious environment. This chapter can answer the last two sub-questions (c and d) of research question 2 which were.

In what ways did STEAM practices make our (PAR team) classroom harmonious and affective driven? And

How did the PAR researchers develop their pedagogical perspectives/practices for transformative sustainability?

Enhancing Harmony through STEAM Pedagogy

I believe that PAR starts to solve the problem of the collaborating co-researchers. Initially, it was started by working on minor changes that the participants can control and manage. After the completion of the plan, they can generalize it to a more extensive pattern of change. Self-reflection and critical self-reflection on their actions made them more mature to deal with the situation. According to Brookmyer (2007), action research is a tool to enhance professionalism which is based upon reflective practice.

In our classroom, we construct knowledge with our students, and action research provides us with context for transformation. Often, we get lost when we

implement our theory in the real world, when we acquire knowledge about something the theoretical knowledge is dominant, and when it comes to implementing certain things always stops us from doing what it actually theory said about it, Action research can fulfill the distance between theory and practice (Chevalier & Buckles, 2019). Being in the education field for more than eight years, I have witnessed that it has lots of challenges, problems, and issues. Participatory action research helps to solve educational problems and gives insights to move forward (Ulla, 2018). Participants in this study should be able to present evidence on how they articulated the thematic concern which holds their group together, and on how they established authentically shared agreements in the group.

As a transformative approach, STEAM pedagogy not only connects the disciplines with each other but connects the learners to the living life. 'A' in STEAM adds how humans need to live like humans which is the common goal of the current goal. The theme-based learning strategy and integrated approach integrate the learners' life into the conceptual framing of academic language. Our experiences in implementing STEAM projects and STEAM practices at the secondary level foster harmonious practices which we had not experienced in our compartmentalized teaching and learning practices.

Joyful Teaching and Learning

Joy is central to learning and joy for learning is central to human integrity. Being a student of mathematics and working as a mathematics teacher for school mathematics I had never realized the importance of affective domains in my teaching and learning practices. I always perceive mathematics as a pure and abstract subject where a teacher is not even allowed to have proper communication and close relations with students. I was superior in the class (I have discussed it in Chapter IV), and students needed to receive everything passively whatever I gave them as holy knowledge.

During this experience as a participant teacher in the intervention of PAR, I realized the necessity of the teacher-student relationship. I realized the power of a smile, a kind word, an honest compliment, and a listening ear toward the students. Listening to their ideas and thoughts also give them enough courage and strength to take risk in their plans. "*Children are far wiser than we think; we should have trust in them*". I collected this statement from the reflection of the computer teacher. His progressive ideas and innovative thinking always motivate us (the remaining

participants) to critically reflect on our practices. He further added that "*if students are given enough space to share what they have learned and what they can do then it can cultivate safe, creative, meaningful, and accountable but joyful space for learning*". His practices in the computer lab were also appreciable. As a participant, I also attended and observed his classes and found enough engaging and democratic. He further added that "*teachers need to act as a caring adults for the students and need to make them feel like his/her teacher is always there in their need; we need to make them aware the life outside the school and need to shape them for both social and emotional skills*". Another participant (English teacher) also opined "*teacher needs to be calm in all the situations and think like a lid in their actions*".

He further added, "*We need to notice students' struggle and encourage them if they are trying; all students cannot be at the same intellectual level though they might be from the same Grade so we should not compare them with each other, such activity may feel students humiliate and produce negative attitude on them*". In this regard, one of the male students in his reflection mentioned that:

Nowadays our teachers are teaching differently. They are using projects to teach and the subjects like mathematics, computer, and English are interlinked. This helps us in relating one subject to another. I am enjoying what is happening with us in our classes. Before this, I have not got such a chance to learn different subjects under a single theme. We worked in many groups which not only contributed to this study but helped us to build healthy relationships with each-others in our classrooms.

Actually, this way of teaching and learning helps me to feel comfortable to clear my doubts. Nowadays, all the teachers seem changed. I don't know how long it exists, but they (teachers) are trying to give spaces and opportunities for our explorations. I am very happy that our teachers are listening to us. I feel like they are valuing us. I used to feel discomfort communicating with my teachers on study matters. The project included here is very different than what we used to practice before. It seems like we are solving one question about mathematics and studying different subjects. Whatever is going on nowadays is beyond my expectations, but I am enjoying it. (From the reflection of one male student, 6 July 2022)

The reflections of students either in written form or in their formal/informal responses in the classroom and outside make me feel like they are enjoying the integrated approach. One boy (Mr. Khadka), a so-called low achiever student in mathematics but a very good basketball player came and sat next to me at tiffin time. I

was waiting for the tea and something to eat. I asked, "*How are you, man?*" He replied: "*I am fine sir.*" He took a pause and asked me:

Sir, which class do you read in?

Are you teaching in colleges also?

What is your further plan?

I answered his questions in a way that he understands. He again took a short pause and asked:

Sir, is this your homework what you are doing nowadays?

I replied to him.

Sir, is this approach will continue with us after your job is done?

Of course, it will be continued. But why are you asking all these? I replied.

He replied: Sir, nowadays I have just started to enjoy the classes. Previously I used to feel difficulty in most of the subjects and can't enjoy them. But nowadays the activities motivate me in the learning process. Sir, now I can solve that problem which we had solved at that stage. That problem is to calculate the area and cost of the umbrella. I have tried one more question from our textbook. I solved that as well. Other friends were also telling that they are enjoying the sessions nowadays. Students the same as me (so-called low achievers) are also motivated in learning and writing those projects.

Figure 7.1

Students' engagement in experiential learning

I realized that our traditional lecture-based approach to teaching and learning practices considered the students as a consumer of knowledge disempowering and demotivating the students from learning and creating new ideas. On another hand,

STEAM pedagogy and practices give ownership and agency to the students. The liberty in exploring the ideas and integrated approach makes them realize that mathematics is also a part of our society. It is evolved from the real-life context and can be connected to our daily practices as well.

Contextualization of the Ideas and Concepts

As a STEAM scholar at KU and a mathematics educator, I found that this approach is not limited to connecting the disciplines to each other but the goal to connect the disciplines is to connect the learners' real-world practices to the teaching-learning practices. As a PAR researcher and a participant in this study, I along with my co-researchers tried to make each project lively enough to address the real-life scenario of the learners. It was quite difficult to address the multi-cultural perspectives in our plan in the beginning but later we found that the learners in today's class are hybrid in these perspectives. We were working in the capital city of Nepal and had a diverse group of cultural practices in the classroom. But what I found is school students are able enough to respect each other cultures and easily delve into them. I even found that they enjoy more with others' cultural practices more. Lively classrooms, an integrated approach along with the contextualization of the ideas were the major criteria in designing our plans.

As a sample work, while teaching statistics students surveyed the data from the students of other classes in their respective groups and perform all the statistical calculations in it. The topic for this project was 'social media'. Students have performed all the statistical work manually in their copies and Excel files on computers. They had also written some essays, letters, and recommendations on the advantages and disadvantages of social media in students' life and beyond that. All the teachers were happy in the virtual meeting when I approached them to connect each idea of our projects to the learners' community practices as far as possible. But the ideas of how to connect it with everyday practices were challenging for all of us. In the earlier stage of the first cycle, I prepared the plans and shared them with my classmates and facilitators, then I modified the plan according to their suggestions then finally I circulate the plans to my co-researchers. The co-researchers (participants) of this study had also suggested their inputs in my plans which were also addressed. The final plan was again circulated with all of them for implementation. In this scenario, each of us had contributed from our side to make our plan contextual as far as possible. We engaged the students in the activities like role-

playing, drama, and fieldwork which gave a close impact on the learners' practices. After the implementation of 2/3 plans from the above setting, we (I and my participants) were able enough to contribute to the contextual activities in our plan.

Sir, students speak in English. This is already connected to their practices. (English Teacher)

Social study is evolved from society. It is already contextual. (Social Studies Teacher)

Mathematics is everywhere in society. Nothing can be separated from mathematics. (Math Teacher)

Everything is science. We cannot separate ourselves from the notion of science. (Science Teacher)

It is the technological era. Students learn to use mobile phones and laptops from an early age. Almost all families in our context have at least a mobile phone with them, so students are familiar with the technological stuff. (Computer Teacher, 2 July 2022)

Those kinds of responses were there from the participant teachers when I first discussed contextualization of the textbook knowledge with them. With those informal discussions, I found them less aware of the notion of contextualization. We had discussed and worked out in several meetings to change their perceptions. During those meetings, I shared some of the projects we designed for our course works. Those projects helped me to convince them easily. And when they were familiar with the idea of contextualization it was easy to shape our plans and activities which may be addressed the real need of the students. I found PAR as a methodological stance in this study helps me to integrate abstract knowledge into their cultural practices. This orientation motivated the learners in their learning and grooms them to tackle the problems in their real-life settings.

ICT's Integration and Use of Computers

The school where I teach is a middle-level school, we have a computer lab and one audio-visual room where teachers and students can get access to projectors. We did not have overhead projectors before, it is our initiation to ask school management to have at least one projector in a class. Using technology in teaching and learning was next to impossible for many of the teachers up to a few years back. Now, many of them are using technology as a tool. This technological growth is the result of restrictive moments the people during the lockdown because of the COVID-19 pandemic. I can remember the teachers who used to have difficulty using some applications on their phones are also teaching confidently in virtual classes. I have

also explored some courses online and added knowledge from there. When they get confused, they approach me, and I help them to shout out their ICT-related problems. It might be because I am a computer teacher here. I can see the great paradigm shift in our colleagues' teaching practices from teacher-centric to student-centric approaches with the help of computers.

Figure 7.2

Students presenting their group works

The proper use of interactive whiteboard and projector has been done during the implementation of STEAM projects. Not only the whiteboard and projector, but I also along with other friends can use Google Classroom and its different functions to track the records of the students. We share our lesson plans on Google Drive, we collaboratively work on making lesson plans, and we give feedback to each other. I had doubts regarding time management, but this issue has been sorted out, and the proper plan and collaboration with other subject teachers had cut off the unnecessary or avoid replicating activities in the classrooms. (From the reflection of the Computer Teacher, 5 July 2022)

The above paragraph is collected from the reflection of a computer teacher. The role of technology is crucial in this intervention. The conventional belief and practices of teaching and learning are challenged due to the techno-friendly society (Pant, et al., 2020). Milner-Bolotin (2015) has also mentioned that "Technology is viewed as a vehicle for the exploration of science and mathematics ideas permeating the world we live in, a tool for engineering design, artistic expression, as well as a field of inquiry within itself" (p. 142). Many of the discussions and informal meetings were conducted virtually. The use of Google Docs, Google Meet, and Google Slides were the major areas of our collaborative work. In doing this the teachers like English, Social studies, and Mathematics were not familiar with the ICT tools. For them, I along with the computer teacher conducted a one-day guiding session on Saturday and

made them a bit comfortable in using those tools from laptops and their mobile phones. "*Sir, I have never used such things. I know how to use Zoom on my phone*" argued an English teacher before the intervention. "*I can type the questions but no ideas on other kinds of stuff*" argued by Mathematics teacher. "*I have used computers a lot but I am not friendly with these sites and applications*" argued by social studies teacher.

This was the scenario before we implemented our plan in the context. "In the case of Nepal, the government and non-government sectors have made a significant initiative in terms of promoting ICT in Education, and ICT-integrated pedagogy" (Pant et al., 2020, p. 29). *Using technology in learning was considered a time pass in school, in the name of ICT-tool teachers, are using their phones to use social media*" argued by social studies teacher. It might be true in some cases, but I don't think that it is true for all.

Being a researcher, I found a lacking computer literacy in the majority of my study participants. The purpose of this study is to see the teachers' transformation through this intervention in their professional skills. To achieve this goal, I continuously helped and guided them to achieve positive attitudes and ICT skills on them. In doing this, the participant teachers helped each other. The computer teacher and science teacher performed very well in guiding the remaining teachers for ICT integrations. I used to carry my laptop most of the time with me in the classroom. Playing videos on YouTube, use of GeoGebra in mathematics sessions, and playing any other related materials were my common practices. Normally three teachers (Me, the Computer teacher, and the Science teacher) used to carry laptops regularly in our classes; sometimes we used them, and sometimes not. The use of ICTs in teachers' professional life is one of the competency standards out of the eight domains framework developed by the government of Nepal (MOE, 2016).

As per UNESCO (2018), the prevalence of ICTs can help to achieve the 2030 Agenda for Sustainable Development by being a mediator to create an inclusive society and break the digital divide. Reaching up to the end of the second cycle I found all the five teachers were friendly with those tools which we had integrated into our plans. Though we had introduced limited ICT tools in this plan, I believed that the intervention cultivated a thirst for computer learning in them. "*Sir, now I can use all those tools which you have suggested in this one month's time. I think I may explore other tools as well if I need*" argued the English teacher who was the least ICT-

friendly participant in our group. The experiences of the other participants were also similar. All feel the changes in their ICT skills and mention their positive attitudes towards the use of ICT tools in their professional practices. In this study, we were guided with transformative notions and spent our time exploring the best-fitted approach and pedagogies for our learners. Somewhere we even experienced like we were guided by the practical interest as argued by Habermassian knowledge of constructive interest but the notion of critical self-reflection and empowering self-guided us in the path of transformation. Many authors such as Dirkx et al. (2004), and Kovan and Dirkx (2003) emphasize on everyday actions of people where their emotional conflicts arise, and with that state transformative learning is fostered. The use of ICTs in education was highly prioritized during the COVID-19 pandemic in Nepal but I found the majority of the teachers were limited to only giving lectures in Zoom meetings. I realized that with the pressure from school administration in the use of ICTs without any professional empowerment, explorations teachers are either deadlocked or revert from their responsibility and continue to work in their comfort zone. The authors like Dirkx (1997) argued transformative learning is "a process that takes place within the dynamic and paradoxical relationship of self and other" (p. 83). In general, transformative learning is considered a progressive change (Baldwin, 2019). In my study, we observed a progressive change in our practices through critical self-reflections on our pedagogical practices. The use of technologies in education can improve the students' competencies in STEAM areas of learning (Bundsgaard, 2019). But the authors like Illeris (2014a) accounted that such changes might not be in full ranges in a learning context.

Emotions in Mathematics Classroom

Emotions here can be expressed as the reaction of the students in the learning process. Students' emotions in any classroom are not only limited to their learning but are affected by the teacher's behaviors and their academic treatment towards them. I feel like the panorama of hard-core punishment and deadlock natures of teachers in our schools and especially in mathematics classes trained the students rather than educating them. Researchers like Maharjan (2022) also concluded in his paper that "this hegemonic tradition of education probably killed my creativity and innovation skills" (p. 70). On the other hand, the Nepalese educational framework for curriculum is decontextualized followed by summative assessment as a core evaluation (Luitel, 2009, 2013; Pant, 2015; Shrestha, 2018) might also reserve the learners from the

uniform flow of their creativity. "*I have a very good command in my classroom, no one can speak and disturb me in my classes, and pin-drop silence makes me very comfortable delivering my lectures*". This is how the mathematics teacher has shared his experiences in an informal setting with him. His experiences didn't shock me because I am also from a similar background. But when I read his refection after the intervention of the first cycle plan, I found a different personality in him,

> *As a secondary-level mathematics teacher, though I had years of experience in different schools in Kathmandu, the concept of STEAM education was completely new to me. The project we did in grade X amazed me. I was surprised that we can teach subject matters in an integrative form. Before doing this project, though I have been applying the reductionist approach to teaching in other grades, I strongly believed that it is challenging to teach students in a collaborative and activity-oriented way in grades IX and X, especially when students are more focused and preparing for SEE examination, I had never dared to go out of the box. When I first attended the professional development session by Sandip sir, I gained a conceptual understanding of STEAM Education and ways to apply it in our classroom. During these 2 weeks, I felt that the STEAM approach is very effective for secondary-level teaching, Students are learning concepts and they are very energetic and show high involvement in classwork." (4 July 2022)*

I believe that the words like energetic, fear, joy, pride, interest, etc. refer to the emotional factors in any classroom. I have experienced such emotional factors in my personal and professional journey either as a student or as a teacher. The remaining participants of this study also express similar kinds of feelings about their past experiences somewhere in their reflections or during the informal talks. After this intervention plan, I experienced different experiences in the participants' responses. During the implementation of this STEAM plan, teachers in this study experienced positive student emotions in their classes. Mathematics teacher in his second reflection mentioned that:

> *Students who were never active in mathematics class and always show their frustration in learning mathematics are also enjoying the project work interested to learn in class, solving a problem, and understanding the teachers' explanation depends on emotional factors, and these factors can be affected by the teachers' behaviors, attitudes, and probably the environment of*

> *the school. This integrated plan of the STEAM approach made me aware of those perspectives. I also experienced that teachers' emotions also affect students' learning. I was unaware of those effective aspects in learning before the training sessions and our regular meetings for these projects". (4 July 2022)*

The nostalgic moment that I also experienced during the intervention period from both students and teachers was one more achievement of this study from my perspective. I found his plan as an ice-breaking intervention into the teachers' practices and their perceptions. All the participant teachers in this study reflected their critical thoughts in their regular practices and are in favor of positive emotions of teachers towards the students and their pedagogical practices and positive emotions of students towards the teachers and their study. One informal conversation with the mathematics teacher in the coordinator's office when we two were only there was like this:

> *I always considered myself a super-personality in front of students. I used to believe that being emotionally attached to the students can affect the classroom environment and students' learning. It is good to be strict, rude, and boredom as a mathematics teacher in front of students so that they take matters seriously. I was not willing to entertain my students in any of their concerns besides the curricular matter. I was not even convinced by the notion of this STEAM approach in the beginning. I was just participating with you and in your plan as a colleague. But your workshop and this integrated planning made me curious to know the result of this implication, so I engaged myself in the plan with my full support. Now I realized that the STEAM approach or this integrated approach can replace the fear of the students with relief and frustration with success in teaching and learning mathematics, both as a teacher and a student. I can see the curiosity of the students with the result of the projects. Though I am not familiar with all of these; I think our students are already one step ahead of us. They are techno-friendly and learn anything easily from the internet. I am also trying to update myself to some extent. Hahaha*

This conversation with the mathematics teacher gave me a positive sign about our plan. "*I feel very happy if I can solve a problem, I even want to solve problems, and I feel motivated*." This was the response of any student from the intervention

class. He was considered a low-achiever student and now he is trying his level best to improve. It was not like he has a drastic change in his performance after the STEAM intervention, but we observed his positive attitude towards learning. When I approached the boy after the first cycle of his learning then he replied

> *Nowadays I feel comfortable speaking with the teachers, they seem quite friendly, I still feel difficulty in mathematics, but I enjoy collecting the data and participating in the group work, I am trying to solve the questions as well. Nowadays I am learning from Ankit (his friend) in the leisure classes as well and I can solve a few questions in mathematics.*

Such experiences from the students make me realize the importance of emotions in the mathematics classroom. It can be either a teacher or a student. This intervention makes us realize that to imagine a student-friendly class; as a teacher, I need to convert their fear and boredom towards the mathematics teacher and mathematics contents to relief and interest. We realized that transformative researchers can "draw on constructivist, critical, social and arts-based epistemologies to examine reflectively, critically and imaginatively their lived experiences revealing the historical and sociocultural framing of their personal lives and professional practices" (Taylor, 2013, p. 2). We observe different types of emotions of students in mathematics classrooms some students feel happy in solving problems and they enjoy each moment in mathematics classrooms whereas some feel fear of mathematics and produce a negative attitude towards it. In many cases/situations, the particular problem might be easy to solve but the students' negative attitude towards mathematics restricts them to attempt it. They rarely understand what the teacher tries to make them understand because they don't enjoy learning mathematics.

In such a scenario a teacher needs to look for alternatives to entertain them. We even experienced that few students enjoy mathematics classes but are afraid of tests and exams. They were having worthy performances in the classes but cannot perform desirable in the tests and exams. Such a scenario also creates frustrations in the students learning. Such emotional domains can be addressed with transformative pedagogical practices, and we found STEAM approach can address this in our context. Emotions "are dynamic processes, socially organized and historically constituted" (Martínez-Sierra & García-González, 2015, p. 18-19). So, to address the emotional domains in any classroom we need to connect the learning stuff to the

socio-political aspects, to the historical aspects of the learner, and to create a dynamic learning environment in the classrooms.

From this lens, if students are motivated and engaged in the learning process then obviously, they will learn how to learn and they will learn how to implement what they have learned. Student's behavior and their emotional responses toward it are always related to their current context or the people with whom they construct knowledge. At the moment how they feel certain things and perceive their emotion is contextual and mostly dominated by the classroom cultures (De Corte, Depaepe, Op't Eynde, & Verschaffel, 2011). The emotional bond between teachers and students plays an important role here. Learners' attitude towards mathematics subject, esteem to solve mathematical problems and their attitude during classroom and engagement with the subject and teacher revolves around the emotions of the learners (Boekaerts, 2007; Conn,1986).

Being a teacher and a researcher guided by a critical paradigm I embraced my ways of knowing in my university and engage teachers and students both in the reflective practices of what they have experienced. In this scenario, I would like to remember 'caring pedagogy' as shared by Qutoshi (2019, p. 148) in a book chapter entitled "Cultural self-Knowing" where he reflects himself as a PhD student in KUSOED and as a teacher and teacher educator in his context (Pakistan). Probably I might be guided by research like Pant (2015, 2017), Dahal, Luitel, and Pant (2019), Luitel (2007), and Manandhar (2022) in this discussion.

Transforming from Conventionalism Towards Progressivism in STEAM Pedagogy

Participatory action research (PAR) is an intentional and systematic process of learning where individuals remain receptive to unexpected developments and seize opportunities. It involves utilizing critical thinking to guide action and transforming social actions into "praxis," which refers to action informed and driven by critical reflection. The discourse on 'Transformative Education Research and Practice' in my third semester significantly impacted my personal and professional journey. I found that humans can change themselves and have the potential to change others. Such changes can make a visible impact within and outside of us. Change can be conceived via heightened consciousness. There are differences in approaches, perspectives, and ideas for the change because the world is full of mythos (in Sanskrit it is called '*Mithya*'). I found that transformation is a shift in perspectives when supported by a

shift in practice. In my context, PAR as transformative research is any form of inquiry that brings the voices of those marginalized in society into the research planning and implementation in meaningful ways. Here the marginalized might refers to the participants' teachers who are not satisfied with their professional practices and even students who are not satisfied with the same teaching and learning approach.

From the initial days to the end of STEAM implementation in secondary level students through the participant teachers, after reflecting on each theme or project we experienced different notions of pedagogical practices, the difference in terms of the ways of teaching and learning. All the participant teachers were experiencing something new in their professional discourse. "*Sir, I have never thought about such integration at this level*" argued the English teacher. "*I still doubt that mathematics can be taught better from this approach*": collected from the first reflection of a mathematics teacher. The notion of a disorienting dilemma as argued by Mezirow (1981, 1995) was seen clearly in the earlier stage but enough communication and collaboration with each other made them comfortable to tackle the situation. The theory of transformative learning by Mezirow (1981, 1991, 1995, 2000, 2009) advocates that every individual has a unique way of knowing the world (Christie et al., 2015). This philosophy is probably "deeply rooted in an individual's upbringing, life experience, the culture that surrounds them, and their education" (Code, Ralph, & Forde, 2022, p. 171-172). The theory comprises examining "the psycho-cultural process of making meaning, the nature of meaning structures, and how they are transformed through reflection, rational discourse, and emancipatory action" (Mezirow, 1995, p. 39). He even added that individual adult has their lenses of viewing the world, constructing from their environment and experiences (Code, Ralph, & Forde, 2022).

In this scenario, teachers guided with the technical mindset as argued by Habermas (Grundy, 1989) were aligned in the process of transformation. To emancipate and empower the teachers along with the student we continuously reflect critically on our actions and modify them time and again. The transformation of different aspects like teachers, students, school, and myself as a researcher and a practitioner are discussed under the following subheadings.

Transformation of Teachers

In my experience transformation is an inside-out process. A transformative teacher plays the role of a rebellious character. He/she always looks at the phenomena

from a critical perspective. I found the participant teachers were seeking positive changes in their professional practices. They were enthusiastic about implementing innovative pedagogical practices and empowering the students as responsible citizens. The need assessment and the informal conversation showed that they were practicing conventional practices as teaching and learning methods. But their engaging practices and reflections show that they are developing themselves as a lifelong learner and a change agent in their surroundings. I have plucked some paragraphs from the reflection of the Social Teacher and that was like this:

> *I have encountered that my educational values and belief had fossilized me, and it did not make me a creative and critical teacher. My eyes were covered with my pride and my pre-assumptions. Is the purpose of education only to produce Parrots? I was doing the same previously, but now I have figured out ways to get rid of my old misconceptions and old practices. Firstly, I have found myself as a lifelong learner. During this project, I started developing a passion for reading different articles, exploring myself, and designing lesson plans on my own. Previously, Sandip sir and other friends had to take initiation for lesson plans and class activities, however, these days I can explore in internet and bring various tools and techniques in my teaching and learning. We recently completed our STEAM Exhibition, and I have witnessed the great collaboration of other subject teachers too. We worked together and students demonstrated their models, I was concerned about how I am going to assess them. Now I think I have got the ways. For example, I can do a continuous assessment and a summative assessment at the end. The project works and other classroom participation are kept in the formative assessment. Next week, in my class I am planning to introduce human resource chapters to my students, they will be assigned a few tasks, and for this, I have already prepared a plan without Sandip sir's scaffolding. I believe that I must be responsible for my own teaching. Sandip sir is here just to show us a way and as a teacher, we must take a handover now, and planning, preparation on my own, and frequent collaboration with my other colleagues are some of the key skills I have built.*
>
> *I have been working hard to keep students' data on Google Classroom, I am integrating technology as a tool in my teaching and learning. All the database, ideas, and daily updates are updated in Google Classroom. Now I*

> *can create my tools for teaching and sharing with my other colleagues as well. I have been adapting to the newness in my classroom. I do not follow only the lecture method instead the Inquiry-based learning and Project-based learning where students deal with real-world problems. One month back, I had different perspectives regarding progressive education. I could see only challenges because our school is not so high fit. Students here are from very normal and middle-class families. In other schools nearby and the students from grade 10, rigid curriculum and fixed assessment system hinders students' inner potentiality. But as a facilitator, at least I can move small steps toward transformative learning. This will give me satisfaction. Only grades and certificates do not define my students, what defines them is their skills and how they treat others, the feeling of empathy, and moral values. (From the reflection of the Social studies teacher, 4 July 2022)*

The above reflection of the social study teacher shows that he is in the stage of personal transformation. I have got similar kinds of reflections from other teachers too. English teacher reflects "*I got a chance to learn new ideas regarding the pedagogical aspects and computer skills I learn how to learn as a teacher and the importance of life-long learning as a teacher*". Similarly, the mathematics teacher also reflects "*I still doubt that knowledge and concept of mathematics are impure and subjective in nature, but this dilemma encourages me to learn and explore more ideas and knowledge from this collaborative level and my level also*". Likewise, English teacher reveals "*I was very weak with computer knowledge but the regular support from my friends in this project has fostered those skills in me. I am thankful to my friends for providing a special time for me on Saturday also to improve my skills. This collaborative work helped me to learn so many things where I was feeling lacking on me. I like the notion of STEAM education i.e., the teacher as a change agent and teaching for justice. To establish those notions, I found that I need to establish myself as a critical self-thinker and a lifelong learner.*"

When I read those reflections, I was overwhelmed by one statement, i.e., "*teacher as a change agent and teaching for justice*". One evening I called the English teacher and asked for his time to have a short conversation at night. In that conversation, I asked him what he wants to tell from this phrase. Hahahaha (he laughed) and started to speak; *sir it might be like 'indra ko agadi sworga ko bayan' [explaining something in front of an expert] because you have only explored those all*

things for us, but I started to realize myself as a change agent. I realized that a teacher not only makes changes to students but to their families through the students and to the entire society through those families. This collaborative work makes me aware that a teacher needs to be aware of students' circumstances, their values, and their cultural practices. These feelings energize me to shape me as a change agent. (Taking a pause)

Well, I have used the word justice, to justice my earlier statement and my practices. Working as a co-researcher with you I realize the injustice practices in our pedagogical practices and even in our system. I am an English teacher, so a question strikes me; am I able to justice my teaching for my students? Am I doing justice to the community? Am I doing justice in producing responsible citizens for the country? Is the school doing justice to the audiences (students, teachers, and parents) from multiple perspectives? Nowadays those questions make me conscious and responsible for what I am doing and what I need to plan for. Teaching students rather than teaching content and teaching for transformation rather than teaching for the reproduction of knowledge are my guiding principles to establish me as a teacher who is also a change agent as well as a practitioner of teaching for justice.

Here the expectations of the English teacher might shape the students to detect and identify the societal issues they are facing in their regular living world and look for possible solutions (Bauer & Booth, 2019). Moreover, in this study, teachers developed projects for the experiential learning of the students. It is believed that project-based learning helps the students to get the actual product (Chen & Yang, 2019). On the other hand, teachers also develop the ideas of developing multi-disciplinary, inter-disciplinary, and trans-disciplinary projects in alignment with the STEAM approach. In doing this the role of a teacher is found very crucial as a mentor, guide, and facilitator in implementing those projects and gaining knowledge and experiences from there (Adriyawati et al., 2020; Vossen, et. al., 2019). Research like Afriana et al., (2016) shows that STEM projects can create enough space to explore real-world problems and find possible solutions which might support their future carrier and motivate them in the learning procedure. With the change in perspective and then in their action, the participants visualized the direction of their transformation.

Being a researcher, I believe that transformation is a process, and it does not have any limitations. It is a changing process as a means of one's assumptions and

practices. This intervention helps the teachers to feel like they are not the knowledge transmitter, but a facilitator who help students to create knowledge from their own experiences (Rahmawati & Taylor, 2015). The above discussions and the teachers' reflections also illuminate the direction of their transformation. Their learning from the intervention and the skills they developed from there could be a baseline for them to set their goals of a long distance.

Transformation of Students

As a secondary participant, the transformation of students was also a crucial domain in this study. The interest of the students and their expectations was the major criteria to be addressed in our plans and activities. At the end of this intervention, I collected the responses to the students' experiences as well. During this intervention, I spend my maximum time in the context, I sat with the students in their groups during their group work and activities. In implementing those interdisciplinary projects, we as participant teachers organized the students into different groups and shuffled them after the completion of each project. I found those activities helped them to develop the skills to work in a group, foster communication skills, and reduce their fear of participation and presentation activities. Those students who are so-called 'introverts' are also able to share their difficulties in the group and can learn from there.

Sir, I am asking him/her.

He/she is teaching me.

Sir, I am getting a better learning environment.

Students were replying like this in informal conversations. I tried to inspect their learning and work just to conform to their words. I found many of them were correct in their saying but few of them were not. Though they claimed that they were learning in a better way in a group, they were just wasting their time on gossip and unproductive tasks and later copying the completed work from those who had completed it. I found this as a limitation of group work. Such activities were observed very minutely thereafter and frequent observation and monitoring by the teacher/facilitator were implemented. In doing those STEAM-related activities we found that students can connect their learning with their context and be able to observe the phenomena from multiple dimensions/lenses.

The use of ICTs in the students' learning procedures and developing them to learn from the internet and gadgets was quite interesting. Students nowadays are very familiar with mobile phones, video games, and computers. Though they were less

utilizing their skills in the study I found it quite easy to drag them into the learning environment through ICT materials. Though the school was less fascinated with ICT materials in each class, students utilized the computer lab and the materials available at their homes. Those practices helped them to develop themselves as self-learner.

We even facilitate them to go through the academic sites and make them aware of ICT-related issues. "*Students are not limiting themselves in what we are assigned, they are doing more than that. Nowadays many of these students have their own YouTube channels and websites. They are exploring many things of interest themselves. STEAM approach not only helps them to use ICT tools but shaped them as a life-long learner and a critical thinker*" argued a computer teacher in his final reflection. In the formal and informal conversations with another participant teacher also, I found STEAM approach can add a different dimension to school students which can motivate them in the learning process and make them responsible for what they are doing.

In this scenario, I found our role as *teachers as a gardener, not as a god*. Gardener in the sense to nurture and care for the students and not a god to deliver the so-called holy content (reproduction of the knowledge). The "head, heart, and hands model" of transformative learning (Singleton, 2015) was in consideration while designing the STEAM projects. It offers enough engagement of the students in the learning process and addressed their affective and psychomotor domains. The skills learners learned during class fostered their creativity and critical thinking skills not only this they can collaborate with their friends and discuss the current scenario and issues that the world is facing at the moment. Sharing, ideating, exploring with peers, and looking for resources help learners to be self-equipped and be a designer of their own work (BCMOE, 2018). Technological advancement has brought effective classroom engagement of learners followed by constructivist learning theory (Barak, 2018; Bilkstein, 2018). As I argued earlier ICTs were taken as crucial components in this PAR intervention; students have got enough space in policing their digital literacy and ICT involvement. Such literacy includes "technical, cognitive, and sociological skills to perform tasks and solve problems in digital environments" (Eshet, 2004, p. 93). The students were not limited only to what they were assigned to do but they explored much more than that (Rais, 2010). At this stage, I can share that we as a teacher also learned computer skills from the students. Sometimes they helped us in

recalling our knowledge that we had forgotten and sometimes new/updated knowledge that they have explored on their own from the internet.

Transformation of School

Nowadays we are experiencing a different environment in our school, with differences in the sense of teaching-learning activities and teachers' attitudes to seeing one another. Although five teachers apart from me at the secondary level are working as a participant in this study, the entire school is advocating for STEAM education and an integrated approach. I don't know outside but each teacher inside the school compound is talking about the integrated approach and trying to link the chapters and knowledge to one another. Whenever I visited the staff room, they requested me to go through their plan. They are giving their best and I am also supporting enough from my side. The school's pedagogical practices are in the transforming phase and transformative ideas are in the incubation period.

Teachers are trying to integrate the themes-based approach in their classrooms. In this initial phase, they are not able to connect all the disciplines, but they are integrated with the possible subjects. In the majority of the classes Nepali, English, and social study are linked to take a holistic picture whereas the subjects like math, science, and health are trying to link up. Now the entire school and the classes seem familiar with the phrase STEAM-approach. Though they are not fulfilling all the expectations of STEAM practice; I am sure that they can do well in the coming future. In my experience, there might be two reasons that the school is influenced by us. The possible one might be the training/workshop session for all the teachers in the researched school and the second one might be the coordinator of the school as a research participant.

The researched school has changed the school timing as well and scheduled 1 hour time for each period. Previously the classes were of 45 minutes. Our research plan might be the reason behind striking this idea in the coordinator's head, but it was possible because the government has reduced a few subjects from the school curriculum and it became feasible to extend the time for each class. *I don't know where this road will take me and my students, but I have the vision to be a better educator and try to provide a good learning environment for my students. I am developing my skills as well. (From the reflection of the computer teacher)*

During the formal and informal conversations with the teachers in the school, I found the inherent willingness on them to be a better version of themselves. Though

they are teaching for a long time not satisfied with what they were doing. In this scenario, this practice in this school was like a blue ray of early morning from the sun which indicates that darkness is going over, and the day is beginning. The overall scenario of the school was towards transformation but few teachers in the lower grades were not happy with me.

Sandip sir; because of you, we are getting extra burdens.

Why do you need to do all this in our school only?

These planning and meetings are wasting my time.

All teachers are doing so I also need to participate but I am getting irritated with all these.

I am no more interested in it, but the heads (Principal and coordinator) are asking for the plans and insisting to do all these under your guidance.

This conversation with a female teacher teaching at the basic level shows her frustration with STEAM practices. She was not a participant in this study, but her statements and conversation made a remarkable impact on me. I found their earlier practices was moreover cognitive driven rather than affective and psychomotor. Probably they might be less aware of affection and emotionality in education. In this regard, Goleman (1998) points out that "our entire system of education is geared to cognitive skills . . . but when it comes to learning emotional competencies, our system is sorely lacking" (p. 244). I found that some teachers are happy with what they are doing without analyzing its impact on the students. They think like the majority of the students are doing good in their subjects, if a few of them are not able to cope then that is their problem; they will take the tuition classes and recover it.

"*If my pedagogy was not working well then all students would fail the exam, but this is not the scenario, so I don't need this progressive approach for teaching*" one of the teachers argued from a basic level. Few teachers were showing their reluctance in transforming their skills from the so-called teacher-centered approach to the student-centered approach and advocate for compartmentalized ways of knowing. But "discipline separations may serve the infrastructures of schooling, and enable disciplinary elitism, but they do not reflect authentic living and learning" (Steele, & Ashworth, 2018, p. 22). I even experienced that the majority of humans always favored their comfortable zone rather than taking challenges and risks. Probably, the integration of arts in their regular pedagogical practices might empower them to "draw on curiosity, observe accurately, construct meaning, and express oneself"

(Sousa & Pilecki, 2013, p. 11). Though, I can see the transformation of the school from this intervention; few of the teachers are not satisfied with what I was doing; despite this, they were working on the integrated plans. I hope they might be convinced one day when they realize that their students had gained something different than usual teaching and life skills for a better living.

I believe that my research practice will somehow transform teachers, students, and the community in the long run. The positive change from transformation is always a long process of thought, action, and reflection (Cranton, 2002). The shifts in school practices might evolve with the shift from each practice. Transformative learning causes an individual to "come to a new understanding of something that causes a fundamental reordering of the paradigmatic assumptions s/he holds and leads him/her to live in a fundamentally different way…. transformative learning and education entail a fundamental reordering of social relations and practices" (Brookfield, 2003, p. 142). This scenario shows that learners are not transformed in isolation (Brookfield, 1995) and they need a favorable environment for it. From this intervention I experienced that, sometimes we may need to nurture the school's environment like a small plant for its transformation.

Transformation in Researcher's Practices Being a Participant

Playing a role of a researcher and a participant at the same time was a quite challenging task for me. On one side I was engaging the participants in preparing the STEAM projects and scanning the data from the context and at the same time, I was working as a participant teacher in implementing that project. I am also a teacher at the same level for more than one-decade time teaching school mathematics and an educator and researcher at the university.

It was more sophisticated to plan the research and projects for me at the table sitting with my classmates virtually. It was not even that difficult to address the facilitator's suggestions and meet their expectations. It might be because we (students and teachers are universities) were guided by similar kinds of schools of thought. Book reading, article discussion, and assignment writing were my regular practices. Usually, I used to critically reflect on my practices in the assignments. Reviewing the articles and writing based on reviewed literature were my common practices. Before starting this PAR as a field study, I used to think of it as an easy task. When I emerged myself in a real-life context it gave me a different kind of experience. Different here in the sense of distorting my pre-assumptions or PAR. I realize that a

researcher needs to be ready for any kind of situation. The real-world situations might not be as easy as I used to think:

Participants are there,
I will guide them in the plan,
The plan will be implemented,
There might be some changes,
I will collect the data,
Participants will provide their reflections,
I will write/interpret based on their experiences.
Work is done! Finished!

These were my pre-assumptions before the PAR intervention. As a researcher and a participant teacher, I found my transformation through this intervention. As I mentioned earlier that is how I used to think about PAR intervention and what did I experience. On standing in the shoes of the research participant I bounced back in a mature form each time. Experiencing the context as a research participant is different than being simply a scholar at a university. Collaboratively drawing the plan, collaborating with the teachers of different disciplines, implementing the plan, and again critically reflecting upon my action was a novel practice for me as well. This was the time when my vicarious experiences as a STEAM practitioner were converted into lived experiences. Along with the other participants, I also learned how the projects can work in our context and what sort of hybridization we need from the so-called Western practices.

I found myself a better version of myself as a mathematics teacher and an educator after this intervention. I learned how those plans can work, and how I can integrate my plans with other teachers. The difficulty I faced in the collaboration and managing the context made me more aware and mellowed me to practice such a study in another context. After this intervention, I experienced changes and modifications in my regular practices of teaching mathematics. My assumptions of taking mathematics as impure knowledge as argued by Luitel (2013) was changing into reality. The conflict between the pure and impure knowledge in my mental schema got refined.

How can mathematics relate to other subjects?
Is it possible to integrate STEAM pedagogy in higher Grades?
Is it fruitful to link mathematics with non-mathematical subjects?
Mathematics is abstract and pure. It only gives objective knowledge.

Does the fallibilist view exist in mathematics?

The answers to these questions were explored from real-world practices through this intervention. Qutshi (2019) also agreed with the exploration of the current classroom practice from multi-epistemic ways which helped to know the inner self and external self as a change agent in a diverse cultural setup. I experienced that mathematics is embedded in the real-world context and it can be easily connected to any discipline. Linking mathematical ideas with language subjects and social study reflects the answer of fallibility. This experience, as a participant in my research, makes me aware of every possible image conducted and applied in the context. I found that I was guided by the concept of agency and resilience during this period. The agency is considered a means for liberation, freedom, or emancipation. It talks about social justice and justice for all. It is considered "a vital issue in the conceptualization of social resilience and a theme that resilience discourse has, so far, failed to satisfactorily address" (Bohle et al., 2009, p. 8). I was also enough aware of the context and my co-teachers to maintain their freedom and emancipation through this study. It advocates for the shared purpose or shared interest which was the major notion of PAR.

In the same vein, as resilience is defined as the ability to create possibilities for new initiatives, innovation, and growth, the focus of analysis is centered on the potential, creativity, and capabilities of social actors (Adger, 2006). It is considered as the elasticity and commitment for healthy tolerance. It lies in the affective domain and promotes bounce-back. The discourse of resilience has been dominated by perspectives that stem from ecological system thinking. If resilience is defined as "the capacity of a system to absorb shocks and disturbance and still maintain function" (Berkes & Folke, 1998, p. 12), thus, resilience is measured by the system's stability and the speed at which it returns to its previous stable state.

From this study, I experienced that agency and resilience are continuous circular processes in transformative learning and research. It is also considered as the degree of resilience to play the role of agency. I found that commitment and tolerance might advocate quality standards in my study. But there might be a question; to what extent of degree, I can play the degree of resilience?

Sustainability of STEAM Pedagogies and its Impact

PAR creates self-reflective communities where individuals participate and work together in the research processes of planning, implementing, observing, and

reflecting. The goal is to form communities that are dedicated to understanding the connection between circumstances, actions, and consequences and to liberate themselves from institutional and personal limitations that hinder their ability to live according to their legitimate and freely chosen social values. Being a teacher and an educator, I experienced many changes in our educational practices. Though the majority of our practices are traditional; the teachers here do not deny welcoming innovative and progressive ideas. They might encounter or experience such ideas somewhere else in their scholastic practices and probably implement them in their classrooms as well. The major problem I felt in our system is to continue or sustained the new ideas. In this scenario, I also questioned myself:

How will the participants' teachers continue their teachings after the completion of this plan?

Will it be sustained in this context?

How can I make sure that they will continue this integrated approach?

Is this plan limited only to this research or I can make a change in my participants' practices?

Those questions were frequently roaming in my head during the implementation of my research plan. The participants' reflections also show that they are in favor of the sustainability of this approach but at the same time they had raised their doubts about its sustainability. Some had blamed the curriculum and assessment practices of our country whereas some had blamed the school's practices. My observations and their reflections during the implementation are discussed under the following sub-headings.

Sustainability in TPD

> *The baby inside the mother's womb gets all support to survive, when the child gets out of her womb, the support from the mother gets disconnected and the child has to breathe itself. A mother breastfeeds her child, exactly I am feeling the same emotion at the moment. I did my schooling in a strict Indian school and had a terrific learning experience that I do not want to remember. I had a strong belief and years of practicing traditional teaching-learning methods. I was in a womb for this 1 month; I got all the support from outsiders, Sandip sir, and other colleagues. I appreciate their support however now I am out of the womb and know my colleagues will be there and other supportive hands will be around however I have to do tasks on my own to sustain these teaching*

> *practices. I have learned to read articles, browse different teaching and learning techniques on the internet, and the learning theories which I had read in the Teaching license preparation book and during my B. Ed. study are now understandable." (From the final reflection of the English Teacher, 6 July 2022)*

My informal conversation with the English teacher somewhere illuminated his positive attitude toward the STEAM approach and an integrated approach. His frustration with his pedagogical approach might also motivate him to internalize this progressive approach. But when I visited his reflection after the first cycle, I found something different scenario. At that time, he was not very sure that he will adopt this approach after the completion of this project because he was not able to manage the activities in his classes. At this time, I want to remember Mezirow's 10 stages of personal transformation (Christie, Carey, Robertson, & Grainger, 2015). I found the participant teachers might be around the 8th and 9th stage i.e., *trying new roles and building confidence*. The noisy classroom and students' engagement in their groups and minimizing the lectures from the teacher's side were some challenging tasks for him.

It was quite difficult for me to convince him about the student-friendly classrooms in the earlier days because of his strong belief in the silent classroom and informing pedagogy. He was not against progressive pedagogies, but he wants his students to listen to him in silent mode. When I observe his class then he was trying to make class participatory, but his beliefs were resisting him. It took around one-week time for him to internalize the idea in himself.

> *One of the beauties of STEAM pedagogy is the interrelationship between various subjects. Mathematics becomes meaningful when we can apply mathematics in the real field. This could happen when ideas of fragmented subjects could be brought under a single umbrella. In Nepal, high school education is highly disciplinary. An integrated curriculum has just been started in the primary section especially up to grade three. At the secondary level, teachers are comfortable in their own subjects and most of them neither want support from others nor want to help other subjects. In this scenario, it is a challenging task to make an integrated lesson plan that would be equally beneficial for mathematics as well as other subjects. I got enough support in this one-month duration, so it was possible for me and now I am much more*

familiar with this approach. But is it possible to have integration all the time?" *(From the reflection of Mathematics Teacher, 5 July 2022)*

Being a mathematics teacher, I can also reflect on my earlier days when I found similar kinds of experiences which I discussed in Chapter IV. My autoethnography in this chapter reveals how I could establish myself as a progressive teacher, educator, and researcher. He had accepted in his writing that he is questioning his own practices and critically reflecting on them. His values and assumptions are getting modified by each day and he found a better version of his mathematics teacher on him. Such a write-up in his reflection and in-person conversation with him unpack that he is in the process of transformation. His doubt about the sustainability of STEAM practices is also a critical perspective that can make him more mature in his practices.

Likewise, the computer teacher wrote:

It is a great opportunity for me to work on this research plan. As a computer teacher, I was always in favor of practical orientations in learning. I found that I was just following the routine-based practices on the computer which was not able to grab the students' interest in it. The number of computer students is increasing in the order in the urban areas because of its 50% practical marks but the scenario of theoretical orientation and skills in the computer is the worst. In this situation, the STEAM approach is found as a milestone for me that motivated my students in learning. Theme-based learning helped me to connect the computer with real-world practices. Students are interested in making presentation files and Excel work in their surveyed data. They were not this interested when I had taught these works before; nowadays students are exploring the skills and ideas themselves. I am observing my students more active nowadays and they are learning in a happy environment. (From the reflection of the Computer teacher, 8 July 2022)

Such reflections from the participant teachers make me feel that they have internalized the STEAM approach and have transformed their pedagogical practices. I find that critical self-reflection plays a vital role in the transformation of the teacher.

Similarly, the social studies and science teachers also doubted the sustainability of this intervention in their school in their first reflection but were in favor of this approach in the end. The Science teacher in this study was more like a token participant but he helped us in the technical part of the school setting. Because

of their contribution, we were able to manage the necessary materials for us. Though we were running the projects in Grade X for one month, the science teacher encouraged the teachers of basic level and pre-grades to adopt the STEAM approach in possible cases. As the science teacher here is the coordinator of the school, we felt much easier in executing our plan. In this context, the social teacher in this study expressed:

> *It was not that easy for me to get familiar with this approach. I used to feel like connecting one subject to another and integrated plans are not my cup of tea. The regular meetings, reflections, and modifications in plans were irritating acts in the earlier days. I was thinking about when this project will get over and I will be free from all this. I have also mentioned those feelings in my previous reflection. My elder son is also there in the same class. One day, I tried to know his experience with this plan and what was going on in their classes. I found him happy, and he told me that they are learning in a better environment and getting more exposure to express their opinions and feelings. His answer turned the arrow of my bow towards me. This happened around the end of the first cycle. Then I again reflected on everything that we have done in our group and the classrooms. Students' facial expressions were clicking on my head. I found that I was not enough aware and not participating enough in making plans. Now I realize that connecting the theme-based approach is a better option in teaching social study and probably other subjects. Students can articulate the free writings from their real-life experiences. It's been a month working together on this project and today I am writing a reflection after the completion of the second cycle. I am happy and thankful for this research plan in our school. This plan not only makes a difference in my professional practice but taught me to question my own set of beliefs. My deep-seated beliefs are slowly getting matured with the STEAM approach. Now I can feel myself as a student-centered teacher adopting progressive pedagogies. Now I am advocating for the construction of new knowledge rather than producing parrots from my class. The contents of social study are extracted from the context and society and this approach helped me to re-connect it to the learners' context. (6 July 2022)*

Such reflection from the participant teachers helped me to figure out the sustainability of my intervention. Their supportive hands and innovative ideas in the

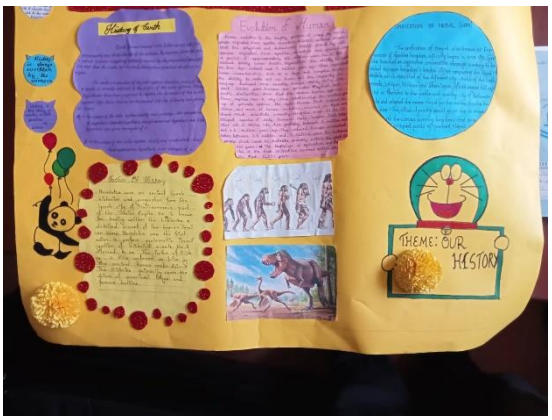
plan helped in modifying the projects and plan after each reflection. I experienced that the teachers from early grades were also reflecting on their actions and some of them used to have an informal discussion with us about the integrated approach of STEAM practices. The transformative notions of critical reflexivity have challenged their status quo and deep-seated beliefs. I believe that "transformative pedagogy not only premises but also proposes to work constructively with learners' vulnerabilities in the face of challenging ideas. Critical dialogue in a transformative setting uses dissent to help learners understand themselves and each other" (Servage, 2008, p. 72). This intervention was not limited to the practical notions of implementation where the participants worked in an approach that seeks solutions to morally challenging situations, but this was more critical and emancipatory where our focus was on the empowering aspect inherent in critical theory, which addresses a wide range of socially relevant educational issues (Burns, 2005). The participant teachers were empowered as learners who seek to narrow the gap between practice and their vision of education (Atiti, 2008). They were able to challenge the great myth in educational practice i.e., "good teachers are born and not made" (Hammond, 2006, p. ix), and guided by the notion of praxis which "enables individuals to reiterate the process of consciousness, practice, and reflective practice in their experience" (Singh, 2012, p. 420). Such practices developed the participants as lifelong learners who might not limit themselves to a particular scene but continuously modify their beliefs and practices.

Sustainability in Student Practices

I am reading in Grade X, and we have eight different subjects separately. Before this grades also used to have many subjects and teachers used to teach them separately. But from the last month, a new practice is implemented in our school. We are working on the projects and the classes after the tiffin break relate to each other. I am amazed by this approach because one teacher is giving a project and all teachers are working on that. There was a project named

Figure 7.3

Theme-based wall magazine prepared by students



'Games'; this was our first project. The topic 'games' was connected with the 'sets' question in mathematics, we solved mathematical questions related to games, we wrote an essay on our favorite games, we wrote a letter to our principal for games classes, we wrote a poem, song, advantages, and disadvantages of games in student's life, we even make our recommendations, presenting these things either in chart papers or making posters in computers and so on. I was amazed for the first time. Being Sandip sir's student for a long time I was familiar with integrating mathematics with ICT materials, preparing hands-on materials, and group work in mathematics classes. Teaching each-others and learning from each-others was common in mathematics but bringing all the subjects under a single heading was not expected.

Anyway, I am enjoying this approach. Yes! Sir has told me it's a STEAM approach. The STEAM approach is almost the same as steam MOMO for me. In MOMO also different ingredients are wrapped inside a small roti and steamed. I love Steam MOMOs and now I love the STEAM approach. I was already habituated to surfing difficult ideas and unsolved mathematical problems on Google and YouTube and solving them from there. Now this discourse in our school makes me more aware of the contextual ideas and I am trying to connect my bookish knowledge with the things which I have seen or experienced. I am not the same learner that I used to be 1/2 years back. I feel like I am transforming and upgrading gradually. At the end of each project, we were supposed to write our learning experiences which was a really difficult task for me in the beginning but later I enjoyed it. I think these reflections make me more aware of my mistakes and other practices which I can correct and modify in another project.

Figure 7.4

A teacher observing students' work

Nowadays I am feeling like I am developing myself as a self-learner. This collaborative approach of our teachers motivates us also to work collaboratively. We feel like we are gaining new ideas which can help us in our academic journey in our life. Working in groups, data collection, presentations in the TV room, and math-science exhibitions were some major skills I gained during this phase. I am very

thankful to all the teachers for creating such space for us and allowing all the students including failures to expose themselves to their innovative ideas. I feel like nowadays our teachers are trying to understand us. I am always proud of all of them. (From the reflection of one female student, 8 July 2022)

I feel like this is what I gained from my profession and this research work. The nostalgic moments with students when listening to their reflections in a conversation and reading their works might not be expressed simply in words. I was very emotional listening to them when I requested them to express their feelings and experiences. It might be the first time in my professional carrier that I was requesting my students to share their learning experiences with me. I also feel like I got a chance to understand them somehow. In general, "our entire system of education is geared to cognitive skills . . . but when it comes to learning emotional competencies, our system is sorely lacking" (Goleman, 1998, p. 244). I realized that 'teaching content' and 'teaching students' are different. I feel like a teacher needs to connect with his/her students so that they can show what they can do and trust their teachers that they are going to be supported if they fall or fail in their journey.

The above reflection is one sample from the students' reflections, the majority of the students had expressed their feelings similarly. I realized that the matter of sustainability depends upon the affection between the teacher and the students. As a teacher, we need to try to understand what is inside the student's head. We must make ourselves humble enough to create students' autonomy in learning and make them feel like teachers are deep-understanding adults for the students. It is also considered that "emotion is the gatekeeper to learning" (McGeehan, 2001, p. 8), and *engagement* and *confusions* are the most occurring and prime emotions in learning (Shen et al., 2009). This intervention in the PAR study makes me realize that teacher-student relations are the central point for the sustainability of learning. We realized that "emotionality should become part of the pedagogical discussion at faculties of education and in teacher professional development" (Steele & Ashworth, 2018, p. 23). Their regular and deep engagement in the STEAM plans also reflects the skills they gained from this intervention are inseparable from their learning. *Sir, I feel more comfortable learning from my friends in a group. I enjoyed learning about my curiosity on YouTube. This different studying culture encourages me in my study. Connecting the textbook's ideas to my real-life context and reflecting on my actions are the most impressive thing I gained from this STEAM approach.*

These are some reflections of different students on their practices during this intervention. Our belief in "Praxis as Critical Pedagogy" (Singh, 2012, p. 421) might also open large spaces for the learners to modify their learning skills and to connect them to their real-world practices. Researchers like Weltman (2002) argued that "good praxis makes possible a self-sustaining, self-perpetuating social movement, a permanent revolution" (p.62). Praxis might be regarded as "action that is morally committed, and oriented and informed by traditions in a field, the term praxis is contested, within and across languages and intellectual traditions" (Kemmis & Smith, 2008, p. 4). The change in school practices along with the participants of this study and students' appreciation shows the sustainability of these practices in the learners. I hope these students will be benefited from this approach in their learning journey.

Sustainability in School's Culture

The culture here refers to the everyday practices of the researched school. I have tried to articulate this section with the impact that our plan and intervention made on the school's practices. The changes that I saw, experienced and felt during the one-month time are discussed under this subheading.

The integrated approach and 'A' of STEAM show its huge impact in the researched school. It can be seen in the cultural practices like '*Krishna Janmaastami*' to the theme-based wall magazine on the school's walls. I felt like wings started to grow on the students' backs as they were flying out for different educational purposes. Now I can see the actual integration of multi-disciplinary actions. Sometimes students were at Sivapuri National Park for the educational tour and sometimes they were on the paddy fields to plant paddy. The scenario of the staff room and teacher gathering on the school premises had also changed its nature. In this context, the English teacher in his reflection said:

Figure 7.5

Kids in a cultural dress on Krishna Janmaastami

> *Everything has changed in this 1 month, our staff room used to be silent, and I used to work alone, only copy checking and hardly speaking with other subject teachers. This is not the scenario right now, we gathered in the staff room, and*

we planned and shared what is happening inside our classroom, what went well, and what could have been done better to run class more smoothly. Our head teacher also seemed happier nowadays than before and I am feeling overjoyed. From the beginning of this research, we haven't collaborated with the Nepali language teacher however after gaining insights I am continuously sharing my ideas and working collaboratively with our Nepali teacher. Most of the components are identical in English and Nepali subjects, only the medium is different, I am happy that I have been able to guide him. Now we are selecting common chapters or themes together and teaching students accordingly. Normally the basic techniques for reading, writing, listening, and speaking are the same. Working in a group and respecting one another's ideas is great. I had never experienced this type of satisfaction before." (From the reflection of the English teacher, 6 July 2022)

The informal conversations with the school management also reflect that they have a positive attitude towards this approach because they insist on me grooming the teachers of basic and pre-level in integrated and STEAM approach. My frequent class observation and supportive feedback for other teachers than the research participants cultivated the STEAM practices in this school. Kincheloe (1991) states that teacher research is important as "a path for empowerment". In addition, such research can minimize the gap between theory and practice or the gap between the researcher and the practitioners (Coulter & Wiens, 2002; Torres & Mercado, 2004). In this scenario, we transformed the pedagogical practices of the targeted school from a "banking model of education" to "problem-posing education" as argued by Freire (1972, p. 65), and from the positivist approach to an emancipatory approach as argued by Habermas (Grundy, 1987). The main idea and motive behind reflective teaching is to become proactive which is a vital component of Praxis-driven pedagogy (Agarwal et al., 2010; Chubbuck, 2010). Such critical scholastic practices create enough room for social justice and advocacy and make the learners prepared for that. Critical researchers like

Figure 7.6

A boy carrying rice plants before implantation

Freire (1972) and Kincheloe (1991) have raised their voices against positivist notions of rationality and advocated for the emancipation of the learner/society for human flourishing. But on the other hand, “the challenge for the teacher who believes in student empowerment is to create an environment which is both stimulating and flexible in which students can exercise increasing levels of power reflecting upon and evaluating the new learner-teacher relationship” (Peterson, 2003, pp. 373-374). Apart from the research cycle, I spend a few more days in this institution to observe and reflect on their practices. All the teachers were trying their best to connect one subject to another. The biggest change I feel and realize in the overall school system was arts (A) integration in their pedagogical practices. Teachers are trying to make dramas and role-play for the students in their classes. The computer teacher (participant of this study) was involving his students in *dohori* (typical Nepali folk song) which contains computer-related ideas. He said that the students had created this song on their own.

Chapter Summary

This is the end of Chapter VII and the end of the data analysis sections. As I mentioned in the beginning, this chapter contained the harmony, transformation, and sustainability of the participants through PAR. This chapter discussed how the PAR team can manage a joyful teaching and learning environment through the STEAM approach. The relationship between teacher and student is found responsible to create a joyful and harmonious learning environment in classroom culture. The real-world connection of textbook knowledge and the integration of multicultural perspectives give life to our pedagogical practices. In addition, the technology is considered a vehicle that connects abstract concepts/ideas of mathematics or any discipline to the students’ understandable form and can add a variety of perspectives in the concerned area. The use of technology made this intervention very comfortable for both the teacher and the student side.

As a critical self-reflector guided by emancipatory interest, we realized the importance of students’ emotions in their learning. The learning of the PAR team from this intervention transformed us from a conventional teacher-centered practitioner to a progressive student-centered facilitator. The transition between the absolutist and fallibilist nature of mathematics was explored and experienced in this intervention. As the PAR team delve into the learning process of STEAM implementation, their transformation in the pedagogical approach was evidence of the sustainability of their practice. Now the upcoming chapter (Chapter VIII) “Final

Reflection, Conclusion, and Implication" is articulated based on the major findings and the insights I gained from this study. In addition, I have presented the possible implication of this study in the forthcoming Chapter.

CHAPTER VIII
FINAL REFLECTION, CONCLUSION, AND IMPLICATION

Chapter Overview

In this concluding chapter, I make final reflections on my journey in designing this research study. My autoethnographic experiences and the collaborative epistemic journey in PAR are summed up in this chapter. This chapter contains responses to my research questions at the first. Along with this, I have articulated methodological insights and then conclusions of this study. I have also included the implications of this study in this chapter. Finally, this chapter ends with my final thoughts.

Responding to My Research Questions

During this journey, I had two major overarching research questions. The first one was *In what ways did my academic experiences develop me as a potential transformative learner, teacher, and teacher educator?* I explored and answered it in Chapter IV. I have addressed this research question with my autoethnographic experiences. My stories as a learner at the school level, at the graduation level, as a teacher, and as a STEAM learner /practitioner are presented in this section. In answering this research question, I developed myself as a critical self-reflector being less/non-judgemental towards myself. In doing this, I explored myself as a spiritual practitioner who considered critical self-reflections as the major of transformation and holistic development. Those stories and experiences might be empathized with by readers of similar contexts.

The second research question, *How did STEAM pedagogy help me and my co-researchers improve our pedagogical practices at the secondary level?* is addressed from the field study (PAR). This leading research question is followed by four sub-questions. They are *How did the PAR team plan and initiate the STEAM pedagogy in their context? How did the PAR team-initiate collaborations and negotiations for the STEAM implementation? And, despite the hopeful perspectival transformation, how did the team experience manifold messiness while implementing it? In what ways did STEAM practice make our (PAR team) classroom harmonious and affective driven? And how did the PAR researchers develop their pedagogical perspectives/practices for transformative sustainability*. These overarching research questions guided me in my research plan and the collection of the data.

The first overarching research question *How did the PAR team plan and initiate the STEAM pedagogy in their context?* is addressed in chapter V where I discussed how I (as a researcher) take the initiative to involve my co-researchers to make this study participatory. I experienced that the researcher's intent in the context can be easily visible to the premise, but it is a difficult task to make other people align with the researcher's purpose. As I discussed in Chapter V, there were both initiators and avoiders in this intervention. The teachers who were likely to participate in this study at the beginning were found less active to participate in the plan because they were much more familiar with the disciplinary approach, and we were supposed to integrate them. It was a major challenge for me to motivate them to walk on the same path with a holistic approach, but the STEAM workshop and students with innovative ideas make it comfortable. At this point, our PAR team realized that students can also participate in making the teaching and learning activities. We even realized that if the students are involved in designing those activities, it will be easy to engage them in the task. Students can actively participate in those activities where they are involved in designing the plans.

Likewise, I responded to the second subsidiary research question; *How did the PAR team-initiate collaborations and negotiations for the STEAM implementation? And, despite the hopeful perspectival transformation, how did the team experience manifold messiness while implementing it?* in chapter VI. The research was indeed conducted to excavate the answer to those research questions. We, as a PAR team, need to collaborate and negotiate at different levels. We realized that the teaching and learning approach cannot be isolated from the premise of school. Though we may feel like a teacher is all-in-all inside the classroom; this intervention made us realize that external factors like school environment, administration, and teachers of other Grades are also directly/indirectly involved in our plans. In this regard, we had a collaboration and negotiation with all the possible factors that were adjacent to our plan. To promote student interactions, we practice some novel practices (like group/pair learning, art-based pedagogy, project-based learning, etc.) in our working station. Those collaborative practices made us aware and critical of what we were practicing in our earlier days and promote us to explore better learning environments for our learners. I found that our (participants of this study) major assumption that knowledge is preserved in teachers' heads like a reservoir, and he/she can transfer it to learners' heads through a pipe was questioned to ourselves. We critically reflect on

those conventional assumptions and practices in which we were following our professional skills. We realized that teachers and students both are equally responsible to create a learning environment and knowledge inside and outside the classroom. The co-construction of knowledge and mutual understanding in designing the projects give a new pedagogical scenario for us. Participants seem reluctant to some extent in the earlier days of this plan. We encourage our students to classroom participation for better engagement in the learning process which was also novice practice for us. Previously the majority of the PAR team members were guided by one-size-fits-all pedagogy and a silent classroom.

Similarly, the third subsidiary research question was, *in what ways did STEAM practice make our (PAR team) classroom harmonious and affective driven?* In responding to this research question, I realized that the biggest gap between the teacher and students is learning. Without a harmonious relationship between teacher and students, there will be less chance of learning with students. In this scenario, affective-driven pedagogy and art-based pedagogy in the STEAM approach were major components for us in this field study. Each project was integrated with all possible areas of learning and the affective domain was always in the center of our projects. I encouraged all the participants in the critical self-reflection from the training days only. Though it was difficult for me to convince them in the initial days for the reflection and participation later they were motivated in the practical process. As a researcher and a STEAM learner, I was quite familiar with all those practices, but my experiences were not real. I was guided by vicarious experiences before the implementation of this PAR study. As a participant in this study, I got a chance to implement what I had learned and got a chance to experience the impact and exposure of STEAM pedagogy in my/our context. Collaborative hands might have explored something new for them in their professional practices with less effort. This practice might have opened their hearts and minds and developed growth mindsets as I argued in the theme *If you meet the Buddha on the road, kill him. (See the last theme in Chapter IV)*.

Finally, the last subsidiary research question in this study is, *How did the PAR researchers develop their pedagogical perspectives/practices for transformative sustainability.* In addressing this research question in Chapter VII, I was very aware of the change I experienced within myself and my PAR team. Though this journey was not as easy as I assumed in the beginning, I experienced some major changes in

all the members of our team. The changes vary from teacher to teacher and the degree of change was also not the same for them. The most common and important change I experienced in our team was the change in the perspective of teachers. Teachers' critical self-reflection made them realize that they might have flaws in their pedagogical practices or can be said like the one-way approach might not fit all the learners in the same class. They realized that a teacher needs to be updated with the current need of the local and global context. A teacher with a growth mindset and mindful vision can support the learners and groom them like a gardener groom a seedling in his/her garden. I even realized that spiritual practices in teaching and learning can take a holistic picture of educational practices that can be connected to real-life scenarios. I realized myself as a different personality if implementing the pedagogical practices inside the mathematics classroom after this intervention. Each of the participant's reflections and interactions also shows that they are level-up their own practices and are motivated to rise more in the upcoming days. On the other hand, the practices of students' learning styles also changed from this intervention. The major change our team experienced during this intervention was the use of ICTs and social media by the students. It might be easy for us because of their young age and curious mind; the majority of the students actively participated in all the interventions and develop skills like self-learning, self-exploration, research, use of ICT tools, and designing the projects based on their real-world practices. In this way, we experienced the pedagogical transformation in our PAR team and PAR context.

Methodological Insights

Adapting a participatory autoethnography study in this research study, the very first and novice experience is a mixed up of two qualitative methodological stances (Autoethnography and PAR) for me. I have already shared my views on adopting multi-genre methods in a single study (see Chapter III). But the real-world implementation of participatory autoethnography in this study helped me in the modification of some of the values and opinions which I have discussed below.

This is my new experience as a researcher in blending two qualitative genres: autoethnographic inquiry and PAR in the same study. The first one helped me to set the scene and shows my transformation from a teacher with conventional practice and mindset to a progressive teacher/educator and the second one help me to test or experience from my own practices what I have learned as a STEAM scholar in my context. While exhuming my memories either as a learner or as a teacher helps me to

question my practices as an autoethnographic researcher. I hope that these stories and experiences help my readers to connect their scenarios with my scenario and get professionally prepared for the integrated practices at the secondary level. Then the implementation of a participatory action plan for secondary-level students made me aware of the possible consequences of those approaches in my/our context. Reflecting upon our context and collaborating (participant teachers) and even with learners in some cases make us aware of the STEAM plans in the schools. I experienced this methodological stance as context responsive approach where I shared 'what I have experienced' from the context rather than 'what I think/perceive'. Moreover, my participatory genre guided by emancipatory interest and transformative learning theory empowered us (the PAR team) with an open mindset and welcoming personality for the novice practices and to develop ourselves as lifelong learners.

Conclusions

This participatory autoethnographic qualitative research study guided by transformative theoretical stances is concluded with some major findings. The autoethnographic section can give insights into the typical Nepali scenario of an ordinary learner/teacher. The stories in this section not only represent my experiences but make the readers aware of a similar context. A teacher/facilitator who is trapped by dogma and considered the learners as secondary might challenge and question their beliefs and practices when they go through those experiences. On the other hand, the collaborative discussion with the participant teachers while formulating the research problem for this study gives insights into their practices along with mine. Wearing a lens of mindful researcher, I experienced that such involvement in our educational system can enrich the transformative thoughts and practices of the participants. The famous saying 'action speaks louder than words' comes out with this intervention in my context. The notion of the STEAM approach could be a way to establish progressive thoughts and innovative ideas in our teachers. The autonomy, recognition, empowerment, ownership, and sustainability of our practices are represented and discussed in Chapters V, VI, and VII. The lived experiences of the participant teachers from their reflections, interviews, and /or formal discussion in implementing the STEAM approach at the secondary level are discussed in those chapters.

Yes, we experienced that innovative pedagogical practices could give a significant impact, but a teacher/educator needs to be very aware of the pedagogical crash. Pedagogical crash here refers to the learning gap between the teachers'

practices and the learners' expectations. The so-called effective pedagogies of one context might not be effective in another context. The challenges and opportunities of each place can be different than other contexts. In this scenario, we realized that no pedagogy and no strategies are the ultimate truth; teachers need to explore them according to the need and context of the learners. We even realized that continuous learning is required from the teachers' side to keep them up to date with the novel practices in educational dimensions. According to this research, the signature pedagogy could be a best-fit approach at the secondary level.

In addition, there might be a limitation of knowledge in the textbook, so collaboration between the teachers for the students' empowerment can help to set a holistic picture of the skills to be learned and the pedagogical approach. To set this holistic picture and fosters communication and collaborations between the teacher-teacher and teacher-students the STEAM approach played a crucial role in our context. Our belief as a traditional teacher that students and teachers are like opposite poles in a magnet was challenged by this approach and helped us to create a boundaryless learning environment where teachers and students seat together to find the best-fit approach for them. In doing this, we experienced arts as a living pedagogical approach that can address all three domains (cognitive, affective, and psychomotor) of the learner. We have observed the significant impacts of arts in the affective domains of the learners and found that emotions and motivations are considered intrinsic factors which can matter in mathematics learning. The projects containing field visits, role-play, and designing materials were highly entertained by the learners. Teachers were actively engaged in drawing their classroom environment full of artistic pedagogical practices.

Each participant's teachers realized the importance of innovative practices like PBL, IBL, ABL, and many others from this study which can be seen in their reflections and interviews. Their transformation from the so-called conventional practitioners to progressive practitioners was possible through the STEAM pedagogical approach. The STEAM approach is found as a complete pedagogical approach in this study which can break the walls of disciplinary ideas and can give a real-life picture in the learning context. As a teacher, we understand that no phenomenon can exist solely in the real world like we had separated the subjects in science, mathematics, English, etc.

No knowledge is absolute and compartmentalized in the world, but it comes up with STEAM nature. The liberty in exploring the ideas and integrated approach makes the students realize that mathematics is also a part of our society. It is evolved from the real-life context and can be connected to our daily practices as well. PAR as a methodological stance in this study helps us to integrate the textbook's knowledge with the actual practices of learners. This orientation motivated the learners in their learning that can groom them to tackle the problems in their real-life settings. During this study, I continuously developed professional relationships with the participants by taking higher responsibility for what we were doing and for the common good by being curious, open, and discernible with the participants, students, and context. Connecting the textbook's ideas to our real-life context and reflecting on our actions is the most impressive thing in this study which help all the participant teachers to question their practices and remain aware of their practices.

The critical self-reflections upon our practices made us aware of the notions of learning, unlearning, and re-learn. Taking ownership of our job and the sustainability of what we have learned might be a big issue in implementing any novice idea in any context. But the empowerment of the participant in a one-month duration and recognition of their ideas, thoughts, and practices make them realize what could be a better approach in each step. Such enthusiasm in the participant teachers might have justice for this implementation and found their pedagogical journey as 'teaching for change' and 'teaching for justice'.

Implications of the Study

The implication of this study might be multiple-faced. As this study is a participatory autoethnographic study with multi-paradigmatic stances educational stakeholders can utilize its findings in multiple dimensions. But this study might not be that much fruitful for those teachers and educators who are guided by a conventional mindset and do not want to get rid of it or want to limit themselves in their boundaries.

As the government of Nepal already executed an integrated approach at the early basic level, this study can be utilized to understand the pros and cons of an integrated STEAM approach at the secondary level for the curriculum developers and policymakers. Such study in the Nepali context can build pillars for innovative pedagogical practices and might make people believe in those practices.

The field study of this research visualized the real-world reflection of the STEAM implementation at the secondary level. In this scenario, a secondary teacher can be aware of his/her pedagogical practices and can take this study as a reference for the collaborative STEAM approach. The real-world settings and the teachers' reflections on their practices in implementing STEAM plans can make the readers empathize with their scene.

In addition, this study is equally important for educators and policymakers to set their plans and policies based on the innovative integrated approaches at the secondary level.

Research Limitations

Although I had the willingness, I was limited in different things in the research context. As an autoethnographic inquirer, I was limited only to my academic journey (in pedagogical practices) in this study. But I believe that there are numerous factors like parents, society, policy, students' interests, students' physical, mental, and social status, economic factors, and many more. In talking about the PAR context, my research purpose and research limitations restrict me from some other things. Though we had collaboratively practiced the STEAM approach in Grade X, students and teachers of other grades were also showing their interest in it and requested me integrated them as well in this study. We have conducted workshops and other informal sessions for all the teachers in the school, but I was unable to guide and observe them frequently. The school administration and teachers from the basic level were also expecting some input in their work but as a researcher and a facilitator, I was only able to provide some sample plans and guide a few of them in our common free time (like leisure periods). Time boundary remained another limitation in this study.

My Final Thoughts

I might not be able to express everything that I have learned during this research study as my final thoughts but I am writing as far as I can express myself. Firstly, I can say that I have learned how to blend two qualitative methods in a single research study. Likewise, the critical self-reflection upon my own set of belief and practices and their discussion with the existing literature resilience me in each step of this study. Secondly, the PAR approach helped me to make my assumptions realistic. Previously, I used to argue based on the literature I studied while advocating for the STEAM approach but now I can express myself with the evidence I gained from the

context. The pain and gain I experienced in the context during the PAR study strengthened my belief and professional practices. I feel like a more mature teacher while entering any classes after this study, matured in the sense of my practices. For instance, I was guided by the non-dualistic *Yin Yang* perspective of Buddhist philosophy while implementing those projects of STEAM practices and collecting data.

In conducting fieldwork in this study and collecting the data from the context I tried to remain mindful enough to extract the actual reality and the effect of my plan. The mindfulness perspective of non-dualism also guided me. This perspective suggests that the truth of existence, where the individual and the phenomena being studied are part of the same reality, arises from the experience of an underlying unity (Singh & Sence, 2016). This research study also believes in and promotes subjective reality which holds the notion of mindfulness. I worked with five participant teachers as a co-researcher and I found two of them as the token participant who rarely participate in the plan but the remaining three actively participated. In this context, as a mindful researcher, I have tried to minimize my influence and frame of reference in collecting the data and observations. Though we worked together in designing the STEAM projects, my prior understanding did not judge their potentiality while collecting their reflections.

Being mindful is a systematic examination of the impact of context and practitioners' expectations, as well as the potential risks, harmful effects, and limitations of the practice. This inquiry is being broadened through the use of diverse methodologies (Davidson & Kaszniak, 2015; Frank & Marken, 2021). Being patient, I observed the phenomena like a beginner's mind. I accepted any kind of result from the context and interpreted whatever I gained from the context. The notion of letting go also guided me to accept any kind of situation in this phase. As I argued in earlier chapters, only three teachers (English, Social Studies, and Science) were in my plan in the beginning, but two other teachers (Math and Computer) also showed their interest in the earlier phase of the study and wanted to participate in it. So, I got a chance to work with active ten hands (five teachers) all together as a primary participant in my study. The notion of accepting the situation and trust with my co-researchers guided me to enlarge the horizon of our bonding that helped me to execute my plan along with their participation.

The context of transformative learning theory (Mezirow, 1991) comes up with the questions like what is the way that I was able to pursue so that I can change myself and my entire society for the betterment. And most importantly, what is that thing that I can work with to heighten my and others' consciousness? The theoretical perspective of this theory lies in communicative learning rather than instrumental worldview where we can make sense of our experiences with the world from subjective judgment. In this context, I experienced that every learner should be reflective critically on the deep-seated and long-rooted underlying beliefs, values, intentions, and attributes (Mezirow, 1997, as cited in Pant, 2017).

In this scenario, mindfulness can show the awareness of the mindset with the phenomena and can critically analyze it. The stillness in mind and dharma and look the phenomena with even-mindedness as a mindful researcher can reflect the actual subjective reality in society. Here, critical reflection matters in raising the questions against existing dominant schema and set of beliefs and always seek for better alternatives. Studies that employ critical perspectives, such as those based on grounded theory, can play a role in uncovering the contextual factors, harmful effects, and obstacles associated with mindfulness practice (Frank et al., 2019).

As a mindful researcher, I constantly strived to enhance my practices by critically reflecting on underlying false beliefs and perceptions about the context, the nature of systems, and my own set of beliefs. The narcissist perspective of the researcher can be challenged through the consciousness in mindfulness which can separate a transformative researcher from dualities energy vampires. The subjective mindset, belief in aesthetic values and non-judgmental are some key features of mindfulness that can shape the future of transformative education and research. In addition, this research study also put a significant contribution to shaping transformative education and research through mindfulness.

I, as a researcher and a STEAM practitioner, understand the relations of body, mind, and heart in the learning context. I realized that each individual is wearing different hats on their heads and transformation does not mean to change one hat as a teacher but to empower from the inner core as a human. Transformation starts with us (each individual) and for that, it is necessary to challenge our dogma. Why this? Why that? We need to look at ourselves critically for the transformation. It is necessary to challenge our habits of mind which are guided by our cultural and societal aspects. A change in outer perspective like gold plating in silver jewellery might not last for a

long time. Transformation cannot happen a night; it demands enough patients and maturity. The ground reality might be very different and very frustrating than our expectations.

As a human, we may even consider the entire world as a classroom for our transformation. This is because we are not only teaching students, but we are teaching their parents, their society, and even the nation. Everybody has their frame of reference, their mental status, societal influences, and cultural and spiritual guidance may not get fit into others' frames. But as a transformative teacher, educator, and practitioner I realized that we need to extend the periphery of our frames and make ourselves much more flexible to accept others' (students) frame of reference. On the other hand, it is also very necessary to know whether the learner can accept and welcome the changes or not. If the intention of the teacher and students is mismatched, then there might be a possibility of 'cultural shock' which may not lead both to the desired goals.

Finally, I got clear that growth happens when learning happens, and learning happens only with the beginner's mind. For this, we might need to empower ourselves (as a teacher/facilitators) with a mindful set of thinking that can serve the student's needs without any biasness based on their needs. But at the same time, still what I found is the notion of mindfulness and thinking as a beginner's mind sounds limited as a philosophy. However, I tried to remain as neutral as possible in the entire situation in this research study but still being a human, I might remain judgemental. This study might be a first step for me in this academic career; I may further explore the implementation of STEAM pedagogies in a large context or for a long period. Further researchers can also explore similar ideas in any other context of Nepal. Mathematics was centered on this study; further research can keep other areas of STEAM in center like science or arts at center and other components contribute to it.

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APPENDIX I

Timeline of Participatory Action Research

The timeline of the participatory action research (PAR) is shown in the following table.

Date/Title	**Work in Detail**	**Time**
April 22 (Friday)	Short meetings in school with the participant teachers, discussed the intervention and planned for the workshops	3:00 to 5:00 pm (2 hours)
May 6 and May 13 (Both Friday)	STEM workshops in the targeted school for all the teachers.	2 hours each day after the school time
May 14 and May 21 (Both Saturdays)	Informal meetings and preparations of sample projects for the intervention.	11:00 am to 2:00 pm each day
Start (*Constructing and Planning Action*)	Phase 1: • Discussion of Plans • Finding out the Problems • Conducting the workshops • Designing the STEAM lessons • Reviewing the lessons for final implementation Ready to implement	Around one month time before the plan implementation.
Cycle 1 (May 22 to June 8)	• Implementing the STEAM Lessons • Conducting interviews and observations for the collection of data Getting feedback and reflections from co-researchers and students	15 working days

June 9 to June 10	• Evaluation of Cycle 1 • Making plans for the next implementation	2 days
Cycle 2 (June 12 to July 1)	• Designing STEAM Lessons • Reflection and finalize the lessons • Enact the lessons • Collection of Data through observations, interviews, written reflections, Obtaining Feedback Assessment of Cycle 2	15 working days
Final Stage (July 2 to July 6)	• Collecting data through interviews, observations, and focus group discussions with co-researchers and students. • Feedback, Learning, Experiences, Reflection • Wrapping up the entire plan	

In the above-presented work plan, my co-researchers took part in every sort of activity starting from the identification of the problem to the evaluation and reflection procedures. Likewise, in each cycle, there was *construct, plan, act, and evaluation* to catch the essence of this study.

APPENDIX II A

Sample Project Used in STEAM Intervention

Kathmandu University School of Education

Department of STEAM Education

STEAM Project Working Plan for PAR-2022

Project Name: Experiential Learning of Statistics

Grade: X

Duration of the Project: 3 Days

The Objective of the Project

This project is expected to develop knowledge, skills, and competency in each of the identified areas of STEAM

Students are expected:

- ➢ to conceptualize the term statistics and thereby stages in a statistical investigation (Through research work by use of Technology)
- ➢ to conceptualize and develop the table of raw and arrayed data separately (By doing a survey)
- ➢ to construct the frequency table also cumulative frequency table (Knowledge, skills, and competencies)
- ➢ to conceptualize and construct the graphical representation of data in Histogram, Line Graph and Pie-Charts (Engineering, Science, Art, and Mathematics)
- ➢ to learn the uses of social media and their effect in day to day life (Science)
- ➢ to visualize the trends in the use of Social Media by school-level students in Nepal and others in the world (by research)

The teacher is expected:

- ➢ to facilitate the learners—conduct the survey, research work, construct the graphical representation of data,

Topic: Use of Social Media

Materials: (i) Pencil (ii) A4 size pages (iii) Color markers (iv) Chart paper (Large size) (v) Rulers (vi) Computer with internet facilities

Question 1: On average (per week, ask all of your friends present today), how long do you use social media (Facebook, Instagram, Viber, WhatsApp, YouTube, WeChat, etc.)

Raw data

Frequency Table

Duration in Hours	Tally Marks	Frequency
0-1		
1-2		
2-3		
3-4		
4-5		
5-6		
6-7		
7-8		
8-9		
Above 9 hours		

Cumulative Frequency Table

Duration in Hours	Frequency	Cumulative Frequency
0-1		
1-2		
2-3		
3-4		

4-5		
5-6		
6-7		
7-8		
8-9		
Above 9 hours		

Question 2:

(i) Find the average time, median, modal class, and quartiles from the collected data information.

(ii) Write a poem about the use of social media in the classroom (you may use the data—surveyed or other sources).

(iii) Write an essay on the use of social media among your grade students of your school at home aligned with your surveyed data.

(iv) Develop a one-page debate—against and for the use of social media in learning

(v) Use the information available (you may explore various sources); relate to other school students thereby the scenario of the world.

(vi) Write brief conclusions highlighting opportunities and challenges created by social media in the study.

(vii) Construct Pie-Chart, Histogram, and a line graph, and explore more charts in Excel.

(viii) Create documentation of the above task in MS Word (if it is not feasible for you, then you can create it manually.

(ix) Write a QBASIC program to find the mean, median, and Quartile.

(x) Create a PowerPoint slide of the above task which you need to present in the class.

(xi) Make a recommendation.

(xii) Submit the report.

APPENDIX II B

Kathmandu University School of Education

Department of STEAM Education

STEAM Project Working Plan for PAR-2022

Project Name: Experiential Learning of Sets

Grade: X

Duration of the Project: 90 Minutes (2-periods)

The Objective of the Project

This project is expected to develop knowledge, skills, and competency in each of the identified areas of STEAM

Students are expected:

- To conceptualize the term Sets thereby statistical investigation (Through research work)
- To conceptualize and develop the cardinality of raw data after identifying the appropriate terminologies (By doing a survey)
- To construct the desired solution of the real-world data (Knowledge, skills, and competencies)
- To conceptualize and construct the Venn diagram.
- To learn the benefits of games in human life and explore different types of games within them (Science)
- To visualize the trends of the use of games by school-level students in Nepal and others in the world (by research)

The teacher is expected:

- to facilitate the learners—conduct the survey, research work,

Topic: Games

Materials: (i) Pen (ii) Copy (iii) Color markers

Question 1: Make groups of your friends and survey your classroom: how many of your friends like Cricket, Football, and Cricket as well as Football. Then, tabulate the data shown in the table given below:

Total No. of Students	No. of students who like Cricket	No. of students who like Football	No. of students who like Cricket as well as Football

Sub-questions:

(i) Find the number of students in the following cases by using the cardinality relation of two sets.

a. Students who like only cricket
b. students who like only football
c. Students who like cricket or football
d. Students who like cricket and football
e. Students who like neither cricket nor football

(ii) Draw a Venn diagram to show the collected data.

(iii) Write a poem about the benefits of games in the classroom on human health (you may use the data/concepts surveyed or other sources).

(iv) Write an essay on the benefits and future of games for students aligned with your surveyed data.

(v) Develop a one-page debate—against and for the benefits of games in students-life.

(vi) Write brief conclusions highlighting opportunities and challenges created by games in the study.

(vii) Make a poster in softcopy form that represents your findings and learning in this project and present it in your class.

(viii) Submit the report.

APPENDIX III

Sample Role Play on Commission and Taxation

टिभि खरिद विक्री

पात्रहरु

डिलर : सेटजी

खुद्रा ब्यापारी : साहुजी

ग्राहक : सन्जु

साहुजीले आफ्नो पसलमा हिजो मात्र ल्याएको टिभिहरु हेरेर मनमनै गुन्गुनाउदै छन् ।

यो टिभि बेच्ने मुल्य तोक्नु पर्ने, एक पटक सेटजी लाई फोन गर्नु पर्‍यो ।

सेटजीलाई फोन लाग्छ ।

साहुजी : हेल्लो सेटजी नमस्कार ।

सेटजी : नमस्कार साहुजी । आज त विहानै फोन गर्नुभयो त दाम पठाउन खोज्नु भएको हो ?

साहुजी : दाम त पठाउला नि सेटजी पहिले भन्नुस त, हिजो पठाउनु भएको टिभि एउटाको मुल्य कति दिनु पर्ने हो मैले ।

सेटजी : ए त्यो टिभिको २० हजार दिनु न । (साहुजीको लागि टिभिको क्र.मु २० हजार)

साहुजी : कस्तो महंगो त, बेच्नै नसकिने भयो त । भाडा १००० लागेको छ, स्थानीय कर तिर्नुपर्‍यो, नाफा राख्नै पर्‍यो ।

सेटजी : ल ल मिलाएर बेच्नु न । अनि दाम चाही अलि चाडो पठाउनु है ।

साहुजी : हुन्छ हजुर कलेक्सन भएपछि, पठाइहाल्छु नि ।

साहुजीले फोन राख्छन् र गुन्गुनाउदै क्याल्कुलेटर थिच्न थाल्छन् ।

क्र.मु. २०००० भाडा १००० र कर ५०० जोड्दा २१५०० भयो । १५ प्रतिसत नाफा राख्दा २१५०० को १५ प्रतिसत ३२२५ जोडिने रहेछ । अनि अंकित मुल्य २४७२५ हुने रहेछ । मुल्य यतिनै लेखेर टास्नु पर्‍यो ।

केहीबेर पछि ....

सन्जु : साहुजी एउटा टिभि चाहिएको थियो ।

साहुजी : हुन्छ हेर्नु न । कतिसम्मको चाहिएको हो ?

सन्जु : त्यस्तै २०/२५ हजारको ।

साहुजी : ल यो हिजो मात्र आएको नयामोडेलको छ । यहि लिनुस् ।

सन्जुले मुल्य हेर्दै भन्छिन् : यसको त २४,७२५ मुल्य राख्नुभएको रहेछ । कति प्रतिसत छुट दिनुहुन्छ ?

साहुजी : ल तपाईलाई ८ प्रतिसत छुट दिन्छु । रु १,९७८ छुट हुन्छ र तपाइले रु २२, ७४७ तिर्नु पर्छ ।

सन्जु : यो त अलि महंगो भयो, भ्याट पनि तिर्नुपर्ने होला ? १० प्रतिसत छुट दिनु न । १० प्रतिसतले २, ४७२.५० कम गर्दा २२, २५२.५० तिर्छु नि हुन्न साहुजी ?

साहुजी : ल ल खासै नाफा त हुदैन । विहानको बोहनी हो लैजानुस् । तर त्यसमा भ्याट रकम चाही थप्नु पर्छ नि । १३ प्रतिसत भ्याट जोड्दा २, ८९२.८० थपिन्छ नि ।

सन्जु : भनेपछि मैले तपाइको विक्रय मुल्य २२, २५२.५० मा १३ प्रतिसत भ्याट मुल्य २, ८९२.८० थपेर रु २५, १४५.३० रुपैया बुझाउनु पर्ने भयो होइन ?

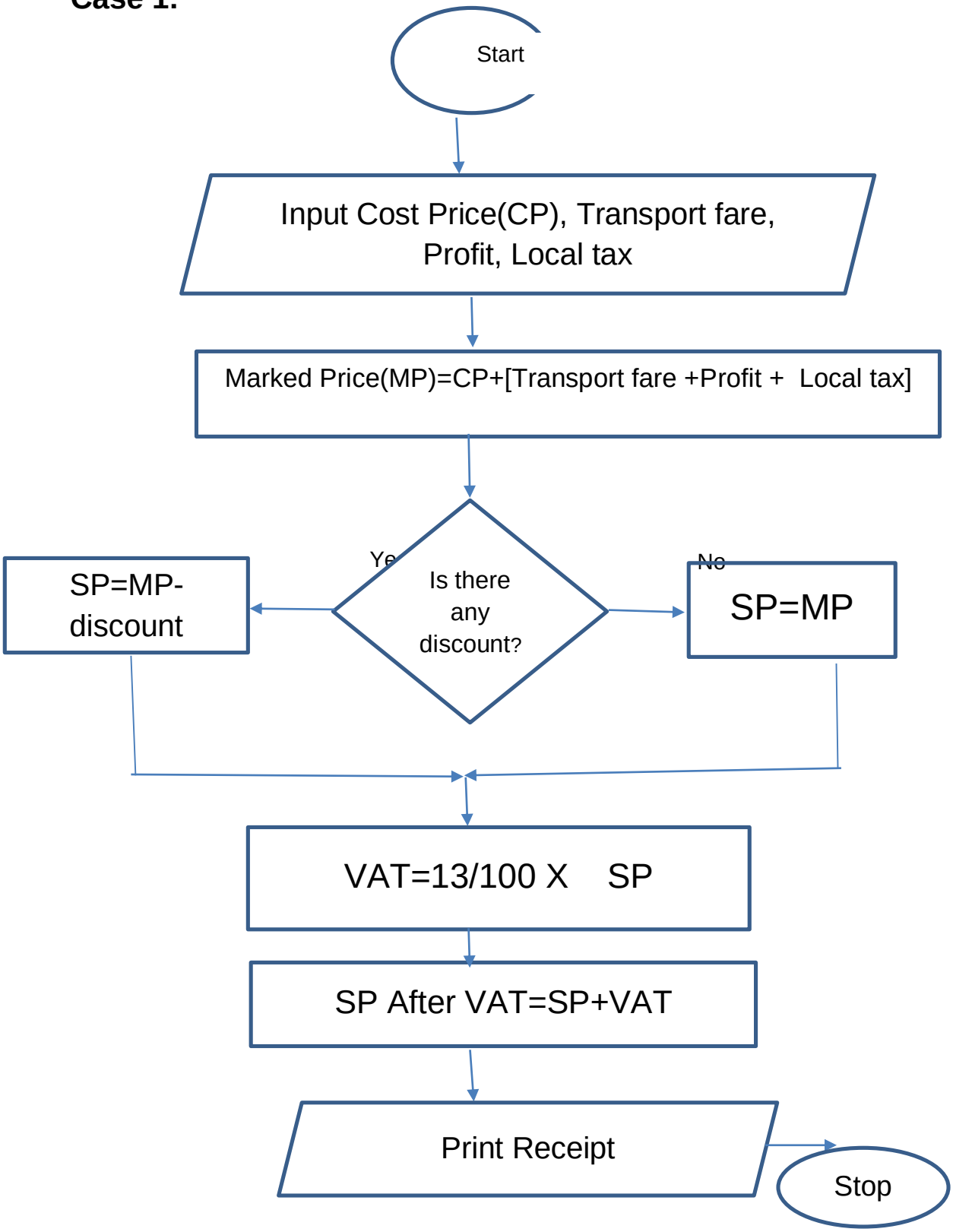
साहुजी : हो नानी

सन्जुले टिभि लिन्छिन् र पैसा दिन्छन् ।

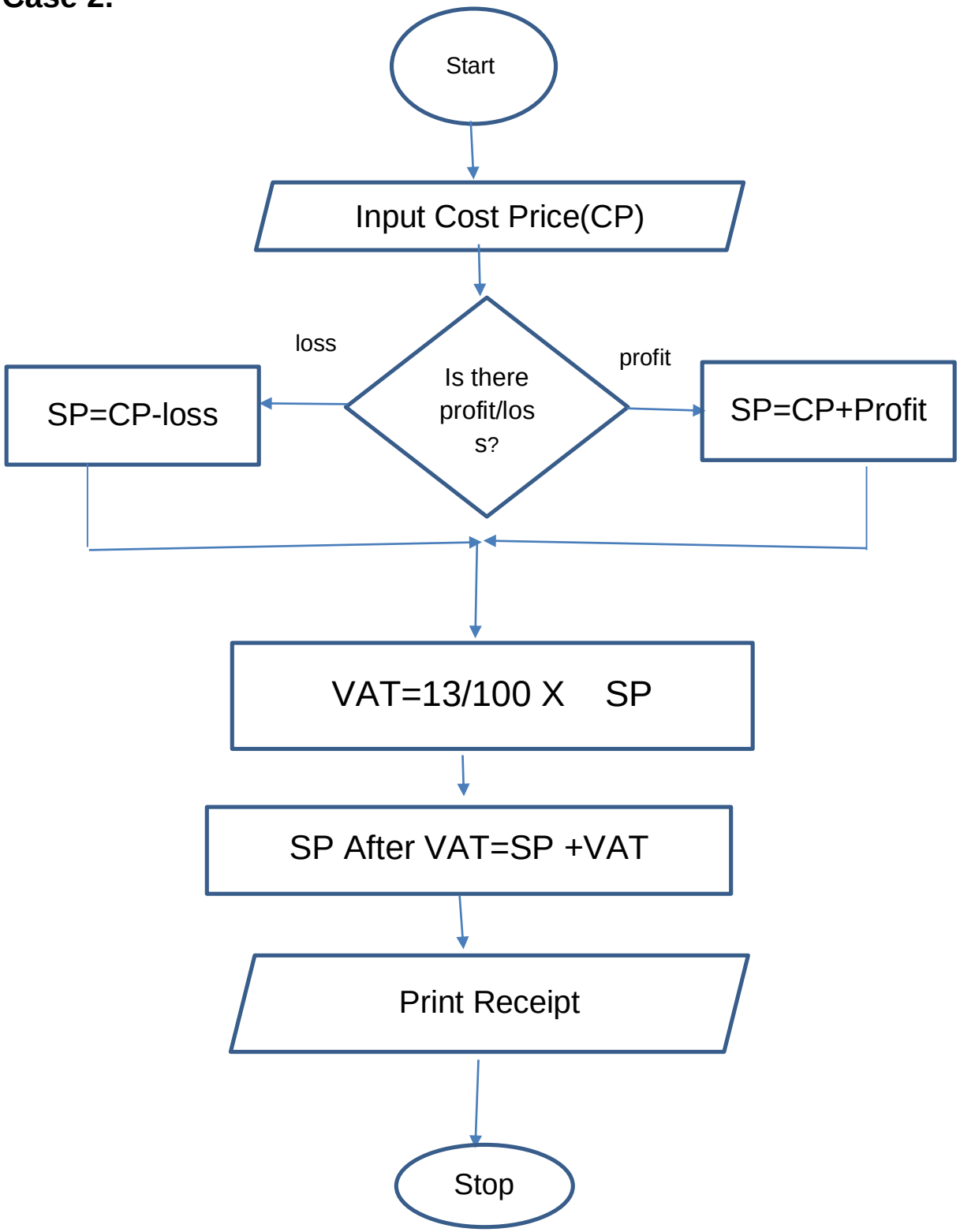
भुमिका अभिनयको आधारमा बनाउन सकिने गणितीय समस्याका नमुना

1. एक पसलेले एउटा टेलिभिजनको अंकित मुल्य २४७२५ राखेका छन् । उनले १० प्रतिसत छुट दिएर सन्जुलाई उक्त टिभि बेचेछन् । सञ्जुले १३ प्रतिशत भ्याट रकमहित कति रकम तिरिन् होला ?
2. एक जना व्यापारीले एउटा टिभि रु २०००० मा किनेर १५ प्रतिसत नाफा राखी बेचेछन् । उक्त टिभिको भ्याटसहितको विक्रयमुल्य कति होला ?

Case 1:


Start
Input Cost Price(CP), Transport fare, Profit, Local tax
Marked Price(MP)=CP+[Transport fare +Profit + Local tax]
Is there any discount?
Ye
No
SP=MP-discount
SP=MP
VAT=13/100 X SP
SP After VAT=SP+VAT
Print Receipt
Stop

Case 2:


Start
Input Cost Price(CP)
loss
Is there profit/loss?
profit
SP=CP-loss
SP=CP+Profit
VAT=13/100 X SP
SP After VAT=SP +VAT
Print Receipt
Stop

APPENDIX IV

Guiding Questions for Need Assessment

Interview Guidelines (pre-action-interview)

1. Greetings…
2. Can you please reflect on the ways of your learning?
3. Why do you think that the teachers were adopting those approaches?
4. Can you please share your present teaching styles? How do you entertain your learners in today's classes?
5. What difference have you experienced in your teaching styles and your teachers' styles in how you were taught?
6. What kind of pedagogical difficulty are you facing in your profession?
7. Have you ever tried anything new to minimize it?
8. Have you ever tried to collaborate with the teachers of any other disciplines in your pedagogical practices?
9. Have you ever tried any type of innovative pedagogical practices like PBL, IBL, ABL, …?
10. Do you have any idea about integrated learning?
11. Do you have any idea about STEAM education? If you have heard, have you ever tried to connect it to your teaching-learning approaches?

APPENDIX V

Workshop Plan with School Teachers Before We Started

Teacher's Professional Development Workshop on STEAM Education for School Teachers [ECD-Grade 10]

Date: May-6 and May-13 (Both Friday)

Venue: Basundhara National Academy (Hall)

Facilitators: Sandip Dhungana and Sarita Khadka

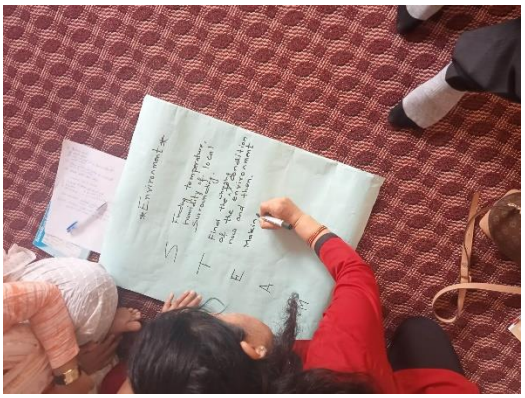
Program Schedule

Day 1 (6 May 2022)		
Time	**Session**	**Remarks**
3:00 pm-4:00 pm	Basic Ideas on STEAM Education: Integrated Education, Productive Pedagogy and Transversal Skills • Differences between STEM and STEAM Education • Art-integrated pedagogy • ICT-integrated pedagogy • Inquiry-based approach • Scientific Thinking	Interactive Presentation and Group Discussion (Sarita Khadka)
4:00 pm-4:30	STEAM Education and Integrated Curriculum [Multidisciplinary, Interdisciplinary, (and Transdisciplinary)]	Interactive Presentation and Discussion (Sandip Dhungana)
4:30 -5:00	Developing Classroom Activities (Lesson Plans) based on Integrated Learning Approach and its sharing	Group Work [ECD, Grade 1-3, Grade 4-6, Grade 7-8, Grade 9-10] (Sarita Khadka and

		Sandip Dhungana)
Day 2 (13 May 2022)		
3:00 pm-4:00	Project-Based Learning in STEAM Education (Inquiry Learning Approach): Developing Classroom Activities (Multidisciplinary)	Interactive Presentation and Group Discussion [ECD, Grade 1-3, Grade 4-6, Grade 7-8, Grade 9-10] (Sarita Khadka and Sandip Dhungana)
4:00-5:00	Inquiry-based Learning Approach (5E Inquiry Model)	Interactive Presentation and Group Discussion [ECD, Grade 1-3, Grade 4-6, Grade 7-8, Grade 9-10] (Sarita Khadka and Sandip Dhungana)
5:00-5:30	Reflection and Sharing	(Sarita Khadka and Sandip Dhungana)

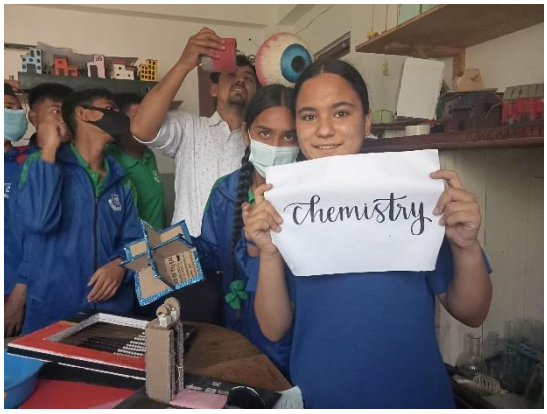
APPENDIX VI

Sample of activities during a teacher workshop session



APPENDIX VII A

Sample of students' activities during different PAR cycles



APPENDIX VII B