ENVISIONING A STEAM-BASED MATHEMATICS EDUCATION IN NEPAL: A *SWA-TWAM-TAT* INQUIRY

Niroj Dahal

A Thesis

Submitted to
School of Education

in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Education (STEAM Education)

Kathmandu University
Dhulikhel, Nepal

July 2025

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[1] *Swa-Twam-Tat* is an alternative research methodology that is proposed to integrate the individual self (Swa), relational selves (Twam—research participants and a critical friend), and universal self (Tat—readers) and beyond.

GLOSSARY

I have used the following terms arising from Eastern (Vedic and Buddhist) traditions.

Advaita	is non-dualism associated with the ontological principle that reality is unified and indivisible.
Ahimsā	non-harm; an ethical foundation for relational engagement
Ākhyāna	is an approach to writing reflective and analytical commentaries embedded in many Vedic, Buddhist, and Jaina texts.
Astitva	being/existence; the interconnected, dynamic flow of reality
Bahuarthavāda	mainly arises from Vedic and Buddhist traditions that promote multiple meanings or interpretations of aphorisms or verses.
Bahuprasnavāda	believes that there are multiple questions or inquiries to solve worldly problems or objects of inquiry.
Bahurūpavāda	promotes that the world is full of multiple forms or appearances, and unraveling them is the basis for moving towards the Truth (e.g., Emptiness, Wisdom, Ultimate Reality) (plurality of perspectives/representations)
Dharma	is the moral law, duty, or the right way of living, and is associated with possible duties that produce knowledge and service in a non-violent way.
Gyāna Pranāli	refers to worldviews or systems or methods of producing knowledge, which gives emphasis on inner and outer, word and experiences, and personal, dialogical, and universal self as the basis for knowledge creation.
Gyāna/Jñāna	Knowledge/wisdom, emphasizing subjective and spiritual insight
Karma	is associated with actions that include moral ideals and virtues
Karuṇā	compassion; central to relational ethics
Mokshā	liberation leads to freedom from all sufferings.
Nāma	conceptual labeling/naming of entities (mind-dependent reality)

NāmaRūpa	refers to the essence or identity of something used to show the limitations of category and form of any concept or idea
Prajñā	insightful discernment; intuitive wisdom beyond empirical observation
Prājyanvāda	is synonymous with wisdom as the core of being a fully evolved human ready to connect with existence (i.e., higher Self, Emptiness)
Pramāṇa	valid means of knowledge (e.g., perception, inference, testimony)
Pūrṇatva	wholeness/completeness (holistic integration)
Rūpa	physical form/appearance of entities (observable reality)
Satya-Anubhuti	experiential truthfulness
Sevā	selfless service; ethical commitment to community well-being
Sva-Dharma	personal ethical duty in inquiry
Swa	individual self (first-person inquiry)
Swa-Twam-Tat	is used as an alternative inquiry construct that integrates the individual self (Swa- e.g., my autobiographical self), relational selves (Twam— e.g., research participants and a critical friend who are in dialogic relation with my autobiographical self), and universal self (Tat—cultural and universal Self that could be addressed as readers and *beyond*).
Tat Tvam Asi	the Mahāvākya ("Great Saying") from the Upanishads, signifying non-dual unity ("Thou art That")
Tat	universal self/ultimate reality (third-person inquiry)
Tātva	philosophical contexts denote fundamental truths and elements.
Twam	relational/dialogical selves (second-person inquiry)
Vāda	philosophical argument or 'ism'.
Vimarsha	critical reflection/introspection
Viveka	discernment between eternal (real) and transient (unreal)
Vyāpakatva	Pervasiveness/transferability of insights

AN ABSTRACT

of the thesis of *Niroj Dahal* for the degree of *Doctor of Philosophy in Education (STEAM Education)* presented on 31July 2025 entitled *Envisioning a STEAM-Based Mathematics Education in Nepal*: A *Swa-Twam-Tat Inquiry*.

APPROVED BY

Prof. Bal Chandra Luitel, PhD

Thesis Supervisor

Based on my experience, mathematics teaching and learning in Nepal rely heavily on standardized, one-size-fits-all approaches that emphasize consistency and adherence to set procedures. These processes can limit opportunities for creativity and critical thinking, and students are guided to memorize formulas and steps without understanding the underlying concepts. While this approach is practical in producing high exam scores, it often leaves students ill-prepared for real-world problem-solving and innovation. My inquiry is guided by an overarching research question: How do contextual and universal perspectives contribute to envisioning the transformative STEAM-based mathematics education in Nepal? This inquiry is grounded in theoretical referents and perspectives of transformative learning theory (Mezirow, 1981, 1991, 2000), knowledge constitutive interests (Habermas, 1972), critical pedagogy (Freire, 1970), curriculum images and metaphors (Schubert, 1986), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019). These theoretical referents and perspectives help me interpret field texts, narratives, voices, reflective notes, and lived experiences of myself as an individual self (Swa), research participants, and a critical friend as a relational selves (Twam), and readers as a universal self (Tat).

Subscribing Gyāna Pranāli design space of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda within Swa-Twam-Tat inquiry that foregrounds for exploring the experiences of myself (i.e., individual self), four research participants, and a critical friend (i.e., relational selfves), thereby inviting the readers (i.e., universal self). This alternative research methodology integrating the individual self (Swa), relational selves (Twam—research participants and a critical friend), and universal self (Tat—readers) and beyond that involves a reflective journey through the three dimensions of the inquiry: Swa (Self), Twam (Thou), and Tat (That), emphasizing introspection, relational understanding, and non-duality realization. The methodological approaches of this relational inquiry were reflected based on critical reflections among all participants within the iterative nature of reflexivity, grounded in different dimensions and rounds of meta-reflections of diaries, field notes, formal and informal discussions, vignettes, face-to-face discussions, pre- and post-dialogue, short conversations, and reflective writings integration of spiritual wisdom, experiential knowledge, and academic rigor. I considered my inquiry as a transformative process whereby researchers "create community, advance scholarship, and become empowered within a social context" (Chang et al., 2013, p. 36). These processes connected me to further portray the notion of transformative STEAM-based mathematics education in Nepal, intertwining new meanings and visions of STEAM-based mathematics education with a sense of self, experiences, and knowledge building for fostering citizenship education.

Meaning-making in this inquiry extends beyond field texts and lived experiences but aligns with Ākhyāna writing as the process of inquiry, constructed through interpreting the phenomenon under study and grounded in the philosophical foundations of axiological principles of Dharma (righteousness) and Moksha (liberation), ontological assumption rooted in non-dualism, which posits that the ultimate reality and the individual self are one and the same, and epistemological approach based on intuitive knowledge. Ākhyāna writing as the process of inquiry, I have used dialectical, narrative, metaphorical, poetic, and visual logic and genres (Dahal & Luitel, 2022; Luitel, 2009) considered as a vāda (i.e., debate, discussion, or dialectical method used to explore and establish truth through logical reasoning and evidence). Thus, for meaning-making, I employed a multi-layered inquiry as Ākhyāna analysis of the Swa-Twam-Tat framework. First, I engaged in first-person inquiry (Swa) through journaling, introspection, and autoethnography to reflect on my personal experiences and inner thoughts. Second, I conducted a second-person inquiry (Twam) via interviews and collaborative sharing to explore interpersonal dynamics and collective insights. Finally, I used third-person inquiry (Tat) to examine contexts through ethnography, field research, comparative studies, and document analysis, capturing universal and contextual perspectives. This inclusive approach integrates individual and collective dimensions, offering an inclusive understanding of the field texts, narratives, voices, and reflective notes within the community of 'I'. I have employed Ākhyāna writing as the process of inquiry in transformative, philosophical, artistic, and performative ways for envisioning STEAM-based mathematics education in/for Nepal, incorporating Swa, Twam, and Tat reflections.

In my inquiry, I have portrayed my vision of STEAM-based mathematics education in the context of the relationship between school and school community, engaged pedagogical processes, professional teacher development, leadership development process as reflective leader, and the synergy between local and global knowledge systems for fostering citizenship education incorporating the multidisciplinary, interdisciplinary, and transdisciplinary designs for learning and teaching, integrating technology and incorporating problem- and inquiry-based activities. Furthermore, my vision as a transformative STEAM educator creates a learning environment for learners that nurtures critical thinking, creativity, and problem-solving skills, integrating STEAM disciplines to provide a holistic learning experience for creativity and innovation that leads to citizenship education. My inquiry focuses on bridging the gap between theory and practice as a praxis-driven orientation, promoting interdisciplinary learning, and preparing students to tackle global challenges.

Thus, my inquiry illuminates my journey as a STEAM scholar, revealing the reflections and insights gained while envisioning STEAM-based mathematics education. This inquiry strengthens the conceptual, philosophical, and etymological origins intersecting transformative journeys while envisioning STEAM-based mathematics education.

………………………… 31 July 2025

Niroj Dahal

Degree Candidate

शोधसार

STEAM शिक्षाको विद्यावारिधिको लागि निरोज दाहालको शोध प्रबन्धको शीर्षक " नेपालमा STEAM मा आधारित गणित शिक्षाको परिकल्पना : Swa–Twam–Tat एक संकथन" १५ साउन २०८२ मा प्रस्तुत गरिएको थियो ।

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प्रा. बाल चन्द्र लुईटेल, पीएचडि

शोध निर्देशक

मेरो अनुभवले नेपालमा गणित शिक्षण र सिकाइ मुख्यतः एकरूप, मानकीकृत पद्धतिहरूमा आधारित छ, जसले स्थापित प्रक्रियागत निरन्तरता र नियमहरूको पालना गर्न जोड दिन्छ । यस्ता पद्धतिहरूले विद्यार्थीहरूलाई सूत्र र चरणहरू र तिनीहरूको अन्तर्निहित अवधारणा नबुझिकन घोक्नमा र स्मरणमा केन्द्रित गर्दछन, जसले गर्दा उनीहरूको सिर्जनशीलता र समालोचनात्मक सोचको अवसरलाई सीमित गर्दछ । यद्यपि यस्तो पद्धतिले परीक्षामा उच्च अंक ल्याउन सहयोग पुर्याए पनि यसले विद्यार्थीहरूलाई वास्तविक जीवनका समस्याहरू समाधान गर्न र नवप्रवर्तन गर्न अपर्याप्त बनाउँछ ।

मेरो अनुसन्धान निम्न अनुसारको प्रमुख प्रश्नद्वारा निर्देशित छः "नेपालमा रूपान्तरणकारी STEAM मा आधारित गणित शिक्षाको परिकल्पनामा सन्दर्भ र विश्वव्यापी दृष्टिकोणहरूले कसरी योगदान पुर्याउँदछ ?" यो अनुसन्धान रूपान्तरणकारी शिक्षण सिद्धान्त (Mezirow 1981, 1991, 2000), ज्ञान–संरचनात्मक रुचिहरू (Habermas, 1972), समालोचनात्मक शिक्षण विधि (Freire, 1970), पाठ्यक्रमका रूपकहरू (Schubert, 1986), स्वराज दृष्टिकोण (Gandhi, 1909), र सहभागीतामूलक भविष्य अध्ययन (Ollenburg, 2019) जस्ता सैद्धान्तिक आधारहरूमा आधारित छ।

Swa–Twam–Tat संकथन ढाँचामा, मैले आत्मा (Swa), सम्बन्धपरक आत्माहरू (Twam) अनुसन्धान सहभागीहरू र एक समालोचनात्मक मित्र, र सार्वभौमिक वा वैश्विक आत्मा (Tat -पाठकहरू) को अनुभवहरूलाई समेट्ने बहुप्रश्नवाद, बहुरूपवाद, बहुअर्थवाद, र प्राज्ञान्वाद जस्ता ज्ञान प्रणालीको ढाँचा वा डिजाइनको अवलम्बन गरेको छु। यो वैकल्पिक अनुसन्धान पद्धतिले आत्मचिन्तन, सम्बन्धपरक समझदारी, र अद्वैत बोधलाई जोड दिँदै Swa, Twam, Tat को त्रैविधिक यात्रा प्रस्तुत गर्दछ ।

यस सम्बन्धपरक अनुसन्धानको पद्धति सहभागीहरूबिचको आलोचनात्मक आत्म–प्रतिबिम्बनमा आधारित छ, जसमा डायरीहरू, स्थलगत टिपोटहरू, औपचारिक तथा अनौपचारिक छलफलहरू, संक्षिप्त संवादहरू, अनुलेखनहरू, र आध्यात्मिक ज्ञान, अनुभवजन्य ज्ञान, तथा शैक्षिक गहनता समावेश गरिएको छ। मैले मेरो अनुसन्धानलाई एक रूपान्तरणकारी प्रक्रिया मानेको छु, जहाँ अनुसन्धानकर्ताहरूले "समुदाय निर्माण

गर्दछन्, विद्वता अगाडि बढाउँछन्, र सामाजिक सन्दर्भमा सशक्त हुन्छन्" (Chang et al., 2013, p. 36)। यी प्रक्रियाहरूले मलाई STEAM मा आधारित गणित शिक्षाको अर्थ र दृष्टिकोणहरू निर्माण गर्न प्रेरित गर्छ जसले नागरिक शिक्षालाई प्रवर्द्धन गर्दछ।

यस अनुसन्धानमा अर्थ निर्माण स्थलगत पाठहरू र जीवन्त अनुभवहरू र आख्यान (Ākhyāna) लेखन प्रक्रियाको रूपमा प्रस्तुत गरिएको छ, जुन धर्म (नैतिकता) र मोक्ष (मुक्ति) का मूल्यगत सिद्धान्तहरूमा आधारित छ। अद्वैत ontological धारणा अनुसार, परम सत्य र व्यक्तिगत आत्मा एउटै हुन्, र ज्ञानको अन्तर्ज्ञान ज्ञानमीमांसामा आधारित छ। आख्यान लेखनमा मैले द्वन्द्वात्मक, कथात्मक, रूपकात्मक, काव्यात्मक, र दृश्यात्मक तर्क र विधाहरू प्रयोग गरेको छु (Dahal & Luitel, 2022; Luitel, 2009), जुन vāda (तर्क, संवाद, वा सत्यको खोजीका लागि प्रयोग गरिने विधि) को रूपमा मानिन्छ।

Swa–Twam–Tat ढाँचाको आख्यान विश्लेषणमा मैले तीन तहको अनुसन्धान अपनाएको छुः सबै भन्दा पहिले, पहिलो व्यक्ति अनुसन्धान (Swa) अन्तर्गत आत्मचिन्तन, डायरी लेखन, र आत्मानृविज्ञान प्रयोग गरी व्यक्तिगत अनुभवहरूमा प्रतिबिम्बन गरिएको छ; त्यसपछि, दोस्रो व्यक्ति अनुसन्धान (Twam) अन्तर्गत अन्तर्वार्ता र सहकार्यद्वारा अन्तर वैयक्तिक गतिशीलता र सामूहिक समझदारी अन्वेषण गरिएको छ भने अन्त्यमा, तेस्रो व्यक्ति अनुसन्धान (Tat) अन्तर्गत नृविज्ञान, स्थलगत अनुसन्धान, तुलनात्मक अध्ययन, र दस्तावेज विश्लेषणद्वारा सन्दर्भगत र सार्वभौमिक वा वैश्विक दृष्टिकोणहरू समेटिएको छ।

मैले STEAM मा आधारित गणित शिक्षाको परिकल्पनामा विद्यालय र समुदायबीचको सम्बन्ध, संलग्न शिक्षण प्रक्रिया, शिक्षकको व्यावसायिक विकास, प्रतिबिम्बात्मक नेतृत्व विकास, र स्थानीय तथा वैश्विक ज्ञान प्रणाली बीचको समन्वयलाई समेटेको छु। यसले बहु–विषयगत, अन्तर–विषयगत, र पार–विषयगत शिक्षण डिजाइनहरूलाई प्रवद्र्धन गर्दछ, प्रविधिको समावेशीकरण र समस्यामा–आधारित तथा अनुसन्धानमा–आधारित गतिविधिहरूलाई एकीकृत गर्दछ।

रूपान्तरणकारी STEAM शिक्षकको रूपमा मेरो दृष्टिकोणले सिक्ने वातावरण सिर्जना गर्दछ, जसले आलोचनात्मक सोच, सिर्जनशीलता, र समस्या समाधान क्षमताहरूलाई प्रवर्द्धन गर्दछ। STEAM विषयहरूलाई एकीकृत गर्दै समग्र सिकाइ अनुभव प्रदान गरिन्छ, जसले नवप्रवर्तन र नागरिक शिक्षालाई प्रवद्र्धन गर्दछ। मेरो अनुसन्धानले सिद्धान्त र अभ्यासबीचको दूरीलाई कम गर्दै, अन्तरविषयगत शिक्षालाई प्रवर्द्धन गर्दछ र विद्यार्थीहरूलाई विश्वव्यापी चुनौतीहरूको सामना गर्न तयार पार्छ।

यसरी, मेरो अनुसन्धानले STEAM विद्वानको रूपमा मेरो यात्रा उजागर गर्दछ, जसले STEAM मा आधारित गणित शिक्षाको परिकल्पनामा प्राप्त प्रतिबिम्बन र अन्तर्दृष्टिहरू प्रस्तुत गर्दछ। यो अनुसन्धानले रूपान्तरणकारी यात्राहरूको सैद्धान्तिक, दार्शनिक, र व्युत्पत्तिगत मूलहरूलाई सुदृढ बनाउँछ।

....   १५ साउन २०८२

निरोज दाहाल
उपाधि उमेदवार

This thesis entitled Envisioning a STEAM-Based Mathematics Education in Nepal: A Swa-Twam-Tat Inquiry presented by *Niroj Dahal* on *July 31, 2025*.

APPROVED BY

……………………………… 31 July 2025

Asst. Prof. Binod Prasad Pant, PhD

Head of the Department (STEAM Education)

……………………………… 31 July 2025

Prof. Peter Charles Taylor, PhD

External Examiner

……………………………… 31 July 2025

Prof. Bed Raj Acharya, PhD

External Examiner

……………………………… 31 July 2025

Prof. Bal Chandra Luitel, PhD

Dean/Chair of Research Committee/Thesis Supervisor

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

……………………………… 31 July 2025

Niroj Dahal

Degree Candidate

DECLARATION

I, Niroj Dahal, declared that this thesis is my work for the Ph.D. in STEAM Education degree requirement at Kathmandu University School of Education (KUSOED). It has not been previously included in any other thesis submitted to this or any other institution for an academic degree or qualifications. I have read the KUSOED ethical guidelines and accept responsibility for conducting the procedures in accordance with the guidelines for conducting the thesis. I have attempted to identify all the risks related to this research that may arise during its conduct, obtained relevant ethical and/or safety approvals, and acknowledged my obligations and the rights of the participants. Also, I declare that I have only used the resources referenced in the inquiry.

………………………… 31 July 2025

Niroj Dahal

Degree Candidate

DEDICATION

I dedicate this thesis to STEAM scholars—novices, seasonals, and veterans worldwide. In dedicating this work, I realize that my four years of research shall help conceptualize the Eastern and Western notions of transformative STEAM-based mathematics education, guiding us toward self-realization for humankind.

ACKNOWLEDGEMENTS

I would like to share this achievement with my thesis supervisor, Prof. Bal Chandra Luitel, PhD, Dean of Kathmandu University School of Education (KUSOED), for his tremendous guidance, patience, and expertise that shaped my research. I want to thank him for challenging me to think critically and encouraging me to explore new avenues and ample opportunities in my future endeavors.

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Niroj Dahal, Degree Candidate

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PHASE I
CRAFTING THE ROADMAP OF MY INQUIRY

In phase 1 of my inquiry, I have explored relational ontologies involving the individual (Swa), relational selves (Twam), and universal (Tat) selves. Chapters 1, 2, and 3 detail this ontological journey, outlining my inquiry agenda, purpose, and emerging research questions. An ethically challenging inquiry draws my inquiry to the next level.

CHAPTER I
FRAMING MY INQUIRY AGENDA

Based on my learning journeys, this chapter explores the need for an inquiry into the what, the why, and the how of an emergent and relevant pedagogical framework and/or approach to transformative STEAM-based mathematics education as my inquiry agenda. This inquiry is not limited to my four years of learning from 2020 to 2024, but my learning as a student, teacher, teacher educator, and educational researcher in my early career is the foundation for this inquiry. I want to offer ample opportunities for readers to know who I am and what I will explore in various dimensions of the STEAM approach. So, the hallmarks of my inquiry in Chapter 1 revolve around positioning myself in the inquiry, framing the inquiry problem, the purpose of the inquiry, inquiry questions followed by emerging inquiry questions, the significance of the inquiry, delimitation of the inquiry, my theoretical referents such as transformative learning theory, knowledge constitutive interests, critical pedagogy, Swaraj perspective, and participatory future studies, organization of the thesis and the chapter organization.

> *I found myself in a dilemma. Where should I begin? How do I start? Which theoretical referent or perspective should my research be grounded in? How can I map out my methodological approach? And most importantly, how can I produce an authentic thesis? These questions have motivated me to step up and board on this thesis.*

Box 1: Dilemma

Positioning Myself in the Inquiry

In the process of positioning myself as a PhD scholar in STEAM Education, here onwards, I would like to articulate who I am, why I am carrying out this inquiry, and what my roles and responsibilities are as a researcher grounded in transformative, philosophical, and performative dimensions of qualitative inquiry (Dahal, 2024b; Denzin & Giardina, 2022). As a PhD student, I have ensured that an axiology of relationality influences the formulation of my inquiry agenda. At one level, this inquiry is my own, adhering to the communicative and empowering values and ethical considerations underpinning the inquiry process. Thus, I have articulated and portrayed what I explored in my M.Ed. and MPhil research projects in 2013 and 2017, respectively, as my research journeys; ICT and me: moving beyond the boundaries;

community facilitators: nurturing leadership development processes; conferences and symposiums: paving the path for further growth; and my PhD journey: what have I explored?

My Research Journeys

Pursuing a master's degree from one of the universities of Nepal was my dream project in 2009 AD. With this dream in 2011 AD, I enrolled for the MEd in Mathematics Education degree at Kathmandu University School of Education (KUSOED). In 2013, I graduated from the university with pedagogical visions for empowering students in mathematics education by creating room for improvement in my professional career. Consequently, I explored that traditional teacher-centered, transmission pedagogy and culture, and context-free mathematics curricula and practices give rise to unhelpful binaries that make mathematics less meaningful. Thus, I argued for better relationships with students and student-centered pedagogy to make mathematics more meaningful to the learners. Meanwhile, I unpacked my professional experiences in my master's dissertation entitled, "*Teacher-students Relationship and Its Potential Impact on Mathematics Learning: An Autoethnographic Inquiry*". The study followed autoethnographic inquiry in the form of solo researcher with multi-paradigmatic tradition (Dahal, 2013; Dahal et al., 2019a), which allowed me to represent my life experiences and my role, identity, beliefs, knowledge, and teaching practices to point the finger to self and critique others (Pithouse-Morgan & Samaras, 2020) by portraying lived experiences of my pedagogical practices as a learner, as a teacher, and as a mathematics facilitator. In doing so, my inquiry explored the problems and challenges (e.g., centralized curriculum, disengaged pedagogy, and summative assessment procedures) experienced in teaching and learning mathematics and how to overcome them. It aimed/predicted to promote students' active participation in learning, social and cultural enactment, and transformative pedagogy to enhance the existing practice and make it more meaningful and learner-centered. My M. Ed. in Mathematics Education helped me understand why students often perceive a disconnect between their teachers and the subject of mathematics. For me, it helped to create a discourse for a viable pedagogy to enrich the mathematics pedagogy in my teaching context (Chiu et al., 2025; Dahal, 2013; Dahal et al., 2019a; Dahal, 2020). Likewise, my inquiry in M. Ed. has shown that the teacher-student relationship is a key aspect in Nepali mathematics classrooms. However, mathematics teachers, in general, have not been able to link culture and knowledge. In the process, I realized that the notion of relationships should not be limited to teachers and students. Rather, it can be expanded to the school and school community sphere if we are to develop authentic, meaningful, and engaging educational activities in school mathematics. Therefore, it was one of the unfinished agendas during my master's project that contributed to raising this question: *How are my experiences with the relationship between school and school community in developing an engaged educational process in mathematics learning?*

As a PhD scholar, I journey through a spectrum of emotions—beginning with excitement and curiosity, moving through phases of nervousness and passion, and encountering moments of pressure and isolation. Yet, amidst these challenges, I find accomplishment and remain optimistic, drawing strength from the unwavering support of my mentor, friends, and colleagues to navigate this academic path meaningfully.

Box 2: Ranges of Emotions

Upon reflection, my master's study and professional career went side by side. Hence, I continued teaching by incorporating the knowledge and skills discussed and applied during my master's study. During the process, I felt I was the one who could contribute to mathematics education. My M.Ed. in Mathematics Education has paved the way for me to become a mathematics teacher with a sensibility for activity-based pedagogy. Nevertheless, I envisioned a future where my continued pursuit of knowledge empowers me to take more impactful actions. At the same time, I continued my further study; for that, I enrolled in the MPhil in Mathematics Education at the same university in 2014 to become a *glocally* competent (i.e., authentic and empowering) mathematics educator by understanding 21st-century knowledge, skills, and competencies. The 21st century's knowledge, skills, and competencies may be helpful in my professional career as a mathematics teacher, teacher educator, and educational researcher. In 2017, I was awarded an MPhil in Mathematics Education.

My MPhil study portrayed the existing classroom practices in terms of understanding and using questioning techniques by mathematics teachers (Dahal, 2017; Dahal et al., 2019b). I explored the mathematics teachers' narratives of their experiences using questioning approaches related to mathematics pedagogy to examine the existing mathematics classroom practices. It enabled me to explore how mathematics teachers acquired questioning skills and what questioning strategies they used. During this research, I learned that the questioning techniques reflected a rote-recall approach to mathematical learning. For me, such a rote-recall approach represents a classical pedagogy (i.e., often a traditional approach), as it would have been used some centuries ago when there were no resources (e.g., pen, paper, ICT tools, the internet of things, books). Classical pedagogy emphasizes the structure of learning, foundational knowledge, and the development of thinking skills through traditional teaching methods (Babu et al., 2024). Therefore, it was another unfinished agenda during my MPhil project, and this has contributed to raising the question: *How do my experiences with the pedagogical process of school mathematics contribute to producing non-adaptive (cf. innovative) learners for this century?*

ICT and Me: Moving Beyond the Boundaries

Technologies have played an important role in my personal and professional career. I have experienced the shift in integrating the technologies in teaching and learning as a master's and MPhil level student and course facilitator for some courses at KUSOED and Nepal Open University (NOU). I learned to use technological tools in teaching and learning. Information and communication technology (ICT) has become integral to my personal and professional life, although I do not subscribe to ICT solutionism. This trend persisted even during the COVID-19 pandemic and continued into the post-COVID period. I, too, have experienced this shift. Likewise, in my educational journey, ICT tools and techniques have supported me in teaching, learning, and instructing by enabling personalized learning (Mohd & Shahbodin, 2015). In 2020, because of the pandemic, most rural and urban teachers in Nepal were aware of ICT tools, techniques, and methodologies by participating in various online workshops and webinars about incorporating ICT tools in teaching and learning. They have also become familiar with online platforms for assigning individual and collaborative tasks.

> *There is controversy about the appropriate usage of ICT and the need for acknowledgment of its deployment for different purposes. Even in the era of GenAI or AI, researchers must familiarize themselves with GenAI to effectively address ethical concerns related to cognitive and evaluative abilities.*

Box 3: Uses of ICT Tools

I have witnessed the first-hand impact of ICT tools, techniques, and methodology for teaching and learning, thereby contributing to the professional development of teachers in general and mathematics education in particular. The COVID-19 pandemic accelerated the uncritical adoption of ICT, making it an indispensable part of personal and professional life, as though ICT is the only option for life. This shift was evident as teachers across Nepal, from rural to urban areas, engaged in online workshops to better incorporate ICT into their teaching practices. Tools like ZOOM, Google Meet, and Moodle became essential for synchronous and asynchronous learning. However, despite these tools' widespread awareness and usage, there remains a critical gap in discussions about their empowering application in teaching and learning, especially in the context of generative artificial intelligence (GenAI). This era appears to demand the integration of different technologies to enhance educational outcomes. The ongoing challenge is to ensure that ICT not only supports personalized learning but also addresses the broader question of how professional development initiatives in mathematics education can integrate these technologies. Therefore, another unfinished agenda was technological integration as a part of personal and professional life, and it has contributed to raising this question: *In what ways have my experiences with professional development initiatives in mathematics education integrated different technologies?*

Community Facilitator: Nurturing Leadership Development Process

In 2015, I had the opportunity to work as a *community facilitator of mathematics* in one of the schools in Kathmandu Valley. The term *community facilitator of mathematics* was new to me. The roles and responsibilities were aligned with the head of the department. The position was new and challenging to me. Even though I had never had such an engagement in my previous professional career, some of the roles and responsibilities included reviewing the day-to-day indoor and outdoor activities of the mathematics teachers in the school and providing constructive feedback to all the mathematics teachers daily across the lesson plan, classroom observations, designing outdoor transdisciplinary projects and assessment (formative as well as summative). Likewise, curriculum planning, designing daily lesson plans, decorating the mathematics walls of school as well as classrooms, managing to support the low achievers in each class, nurturing mathematics teachers across classroom leadership to be more professional, and taking the lead role to conduct the school events were some other roles and responsibilities during my tenure from 2015-2020. As a community facilitator of mathematics, I conducted various training and workshops for mathematics teachers in continuous Professional Development (PD) sessions. This opportunity helped me to seek the answers to the questions: Who am I? What are/were my abilities to be in the position of the community facilitator of mathematics? How have I worked as a community facilitator of mathematics? How have I nurtured the mathematics teachers' leadership development process? The advantage of recalling these events is to cherish my earlier practice as a community facilitator of mathematics. Thus, it was another unfinished agenda as a community facilitator of mathematics during my professional life, and it has raised the question: *How has the leadership development process as a reflective teacher leader been taking place in school mathematics?*

Conferences and Symposia: Paving the Path for Further Development

Learning is a continuous process, no matter where we work, in our roles or in our responsibilities. Taking learning as a continuous adaptive process (Boylan, 2018) after my graduation (M.Ed. in 2013 & MPhil in 2017) and ongoing PhD study, I attended and presented my ideas, concepts, visions, commentaries, research insights and/or outcomes, and thoughts in the forms of paper(s) alone or collaboratively in more than four dozen-plus national and international conferences, seminars, and symposiums (**See the details in Appendix III**). These engagements were my foundations for learning, sharing, and networking with scholars worldwide, focusing on inquiry into curriculum, pedagogy, and teacher professional development.

For me, the conferences and symposiums are helpful platforms for actualizing STEAM (Science, Technology, Engineering, Arts, and Mathematics) education and research. These gatherings bring together scholars, educators, and practitioners from diverse fields, fostering a collaborative environment that sparks innovation, cross-disciplinary thinking, and cross-cutting issues. Indeed, conferences offered me a unique opportunity to explore the intersections between creativity and technical expertise. For scholars like me, these events are invaluable for presenting cutting-edge research, receiving constructive feedback, and establishing networks with peers and mentors. Those peers and mentors also serve as a venue for discussing emerging curricular trends in STEAM Education. Thus, by sharing knowledge and experiences, conference participants collectively address challenges and identify new directions for growth. Ultimately, conferences and symposiums in STEAM enhance my professional career and contribute to the broader development of a more integrated and holistic approach to education and research.

Likewise, during my PhD, I attended and presented papers virtually based on my theme of transformative STEAM-based mathematics education at national and international conferences, seminars, and other works (**See the details in Appendix III**). In this section, I intend not to share how many national and international conferences and symposiums (physically and/or virtually) I have participated in and presented my issue. But, how am I nurturing myself in this field? In addition, the interest behind attending and presenting the paper(s) has been to holistically develop my underpinning personal and professional experiences, thereby shifting my habits of mind and changing to track the emergent trends of research, collaboration, innovation, and teaching and learning practices.

I have attended and presented my ideas in many online and/or face-to-face conferences and have paved the way for developing the vision in the field of inquiry. The first online symposium in which I shared my initial research work on STEAM education was *The Ninth Appalachian Ohio Mathematics & Science Teaching Research Symposium* in October 2018, organized by Ohio University, Athens, Morton Hall. I presented the research paper "STEAM Education: Challenges and Opportunities in Nepal". I largely aligned my presentation at the symposium with the STEAM education initiative implemented so far in Nepal. This conference helped me conceptualize STEAM education and/or its framework. Key insights I encountered incorporated the platform created by STEAM to help the students explore the various dynamics of STEAM education and/or framework, and learn to collaborate. I also realized the role of expert human resources for national development by incorporating a robust STEAM framework for a creative and logical way of solving real-world problems (e.g., climate crisis, environmental crisis, preservation of diversity) by integrating technology into mathematics. It was the central notion I realized for promoting collaborative learning rather than a culture of competition. Inherently, my presentation further highlights that teaching mathematics and/or other subjects is not merely to nurture new teachers but also to produce a highly skilled human resource who can do something miraculous for this world via research and innovation (e.g., Dahal, 2018).

Figure 1

Word Cloud of My Engagements in the Conferences

The second conference, which further shaped my concepts or framework of STEAM education, was the *Second International Conference on Applications of Mathematics to Nonlinear Sciences (AMNS-2019)* in Pokhara, Nepal, organized by the Association of Nepalese Mathematicians in America (ANMA) in collaboration with Nepal Mathematical Society (NMS), Central Department of Mathematics, Tribhuvan University and Department of Natural Sciences, Kathmandu University. *STEAM Education: An Eye-Opening for 21st Century Education* was my presentation topic with my co-authors. During the presentation, I explored my voyage of working with the in-service teachers at the school level as they have developed, refined, and implemented problem-based STEAM or STEAM challenges for investigations in their classrooms, focusing on mathematics. This presentation inspired me to develop and implement innovative and integrated pedagogy for STEAM education to promote transformative teaching and learning and contribute new knowledge to change and sustainable education. I have explored and shared helpful insights with the participants wishing to engage in the implementation of high-quality STEAM Education required for the 21st century (see Dahal et al., 2019c).

As a PhD scholar focusing on transformative STEAM-based mathematics education, I have had opportunities to learn from national and international conferences (**see more in Appendix III from 2020 onwards**). These conference experiences have provided me with a sound understanding of knowledge and insights, broadening my understanding of the STEAM field and enhancing my research capabilities and networks. Further, these platforms allowed me to engage with experts, discuss innovative ideas, and stay abreast of the latest developments in the field. These conferences have been instrumental in shaping my academic journey and continue to influence my research in different ways while envisioning transformative STEAM-based mathematics education in Nepal.

As a STEAM scholar, I believe conferences and symposiums are invaluable platforms for fostering growth and innovation. These gatherings at the conferences create a collaboration and knowledge exchange space. Attending such events has been a transformative journey for me, offering opportunities to present my research, receive constructive feedback, and engage in thought-provoking discussions with peers and experts. These opportunities have expanded my understanding of interdisciplinary approaches and inspired new ideas and perspectives that I can integrate into my work. Moreover, conferences and symposiums serve as a bridge between academia, industry, and the arts, enabling me to explore the practical applications of my research. They provide a stage to showcase my contributions, build professional networks, and stay updated on the latest advancements in my field. Through these interactions, I have gained insights into emerging trends and challenges, which have guided my research direction and nurtured my passion for innovation, creativity, and change-driven approaches. Thus, I am paving the path for further growth as a scholar and an advocate for interdisciplinary collaboration by participating in conferences and symposiums.

Likewise, as a researcher, I realized that learning is a continuous and adaptive process, regardless of roles and responsibilities. Even during the COVID-19 pandemic, I have prompted myself as a researcher and/or educator by sharing and conducting virtual workshops for teachers. Through these engagements, I have developed a robust framework for transformative STEAM-based mathematics education, emphasizing collaborative learning. This continuous process of learning and adaptation has been instrumental in shaping my inquiry and teaching practices, ensuring that I reflect on educational innovation and development. Thus, it was another unfinished agenda during and still from the conferences, seminars, and symposiums. It has contributed to raising the question*: In what ways do academic conferences and symposiums help me both in individual scholarly transformation and the advancement of integrated, transformative approaches of STEAM education?*

My PhD Journey: What I am Exploring

In 2020, driven by aspirations of becoming a PhD scholar, I enrolled in the Kathmandu University School of Education (KUSOED) to pursue a PhD in STEAM education. My inquiry aims to contribute to the knowledge world by developing and envisioning a transformative STEAM-based mathematics education for my workplace and beyond. Throughout my PhD journey, I focused on envisioning a STEAM-based mathematics education by examining contextual and global practices. This endeavor aims to create a vision for STEAM-based mathematics education in Nepal. My vision of STEAM-based mathematics education illustrates the intricate relationships between content, disciplines, instructional approaches (e.g., multidisciplinary and interdisciplinary), problem-based inquiry, and lifelong holistic learning habits that promote change and sustainability (Richard & Biffle, 2016). A key aspect of this inquiry for STEAM-based mathematics education is taking transversal skills into consideration, skills applicable across various situations and work settings, and not confined to specific jobs, tasks, academic disciplines, or areas of knowledge (Dochevska, 2020). Arriving at this stage, I have developed several insights and concepts in mathematics education. These include the lenses of STEAM approaches/frameworks, the philosophical foundation of STEAM Education, current research trends in STEAM education, the relationship between schools and communities in fostering an engaged educational process, and the implementation of pedagogical processes to produce innovators in STEAM education. Likewise, I have critically assessed 'What is STEAM education?' and 'What is not STEAM education?' In this alignment, my work explores teacher professional development through the STEAM approaches, leadership development in mathematics and technology education, and the synergy between local and global knowledge systems (**See more in chapters—IV-VII**). These insights and concepts help me explore my STEAM-based mathematics education vision.

Framing the Inquiry Problem through Literature

Informal learning in a family environment and Gurukuls existed before the formal foundation of education in Nepal for selected groups of people (Srivastava, 2009). Of course, the birth of democracy in Nepal in 1951 AD led to the diversification and importance of education, starting from school to university. However, from the beginning of the education system, students at the higher level or in school more often and/or less often are seen focusing on superficial learning (e.g., rote recall, study for exams, confirmatory learning) driven by compartmentalized curricula aligned to a one-size-fits-all approach in a disciplinary design. Even mathematics education in Nepal has also developed through time, being adapted first from the traditional Gurukul system and subsequently from the Western method of education during the Rana rule (1846–1951). The government focused on formal education, introduced by the democratic government in 1951, with mathematics as a disciplinary subject. However, disciplinary design systematically organizes educational content and methods within a specific academic discipline to improve learning outcomes. These practices will likely reduce the education system more to an abstract theoretical foundation of knowledge limited to prescribed textbooks than applicable knowledge to tackle the issue and/or find possible solutions in multidisciplinary to interdisciplinary design, such as community health projects and Nepali cultural heritage preservation in multidisciplinary design and sustainable agriculture initiatives, and designing and implementing sustainable teacher professional initiatives in interdisciplinary design. Multidisciplinary design integrates knowledge and methodologies from multiple disciplines to address complex problems, fostering a comprehensive understanding. Interdisciplinary design merges concepts and approaches from different disciplines to create innovative solutions that transcend traditional boundaries (Leavy, 2016).

Such technical interest-driven learning (Habermas, 1972) does not seem to favor the students to testify their mathematical knowledge across other fields in integrative design, thereby needs an investigation into the possibility of STEAM-based mathematics education by offering the space for critically reflective ongoing actions for change (Mezirow, 1981, 2000). Thus far, the teaching profession is also considered the disciplinary knowledge transmitter from teachers' heads to students (see Dahal, 2013; Pant, 2015; Shrestha, 2018). Mathematics suffers from such a disciplinarity by being a decontextualized and disengaged learning area (Lammichane & Dahal, 2022). Besides, curricula in Nepal are updated over a long interval of years, which does not allow the new generation of learners to get updated ideas, resulting in poor educational activities. In this regard, rote-learning, teacher-centered, exam-oriented, and donor-driven systems are likely to kill students' critical thinking, creativity, and innovation (Dahal, 2013; Dahal et al., 2019a; Dahal, 2022a; Dahal, 2022b; Gnawali, 2018) to challenge taken-for-granted assumptions (Mezirow, 1991, 2000) to envision the STEAM-based mathematics education. Critical thinking involves analyzing and evaluating an issue to form a well-reasoned judgment and standpoint. Creativity is generating original ideas and solutions through imaginative thinking and problem-solving. Innovation refers to translating creative ideas into practical and useful applications to solve pressing *glocal* problems of our times.

Nevertheless, educational institutions play a crucial role in fostering students, teachers, and the community by imparting various generic and transferable hard and soft skills that connect education to their daily lives. This aspect was largely lacking in educational practices in Nepal previously, but now it has become a key focus for educational institutions as they aim to challenge cultural, ahistorical, and apolitical perspectives (Freire, 1970) in STEAM-based mathematics education. Meanwhile, these skills will likely empower students, teachers, and the community to become analytical, critical, creative thinkers and innovators. Analytical thinkers systematically dissect complex problems to understand their underlying components and relationships. Critical thinkers rigorously evaluate information and arguments to form well-reasoned and well-grounded conclusions. Creative thinkers generate novel ideas and approaches by thinking outside conventional boundaries. Innovators transform creative ideas into practical and impactful solutions that drive progress. Problem solvers apply logical reasoning and innovative strategies to address and resolve challenges effectively (Bailin, 1987; Shoop, 2014; Tsai, 2013; Zhang & Wu, 2025). So, hearing and learning different approaches that enhance and/or hinder the emergent focus of my inquiry is to develop a vision for a transformative STEAM-based approach that can enable learners to solve world problems (e.g., climate crisis, environmental crisis, preservation of diversity) faced by our world today.

In this process of recalling and critiquing the present education system of Nepal, the newly reformed curriculum in the federal system of Nepal (CDC, 2019) brings opportunities for learners, teachers, and communities in educational sectors across mathematics by offering integrated ways of designing the curriculum, pedagogy, and assessment. Within the principles of self-rule and autonomy (Gandhi, 1909), the mathematics education community hopes to have exercised its decisive power of innovation in teaching and learning. This form of alternative society within the mathematics education community has helped me develop the vision of STEAM-based mathematics education in Nepal. The federal government has delegated some authority to the local level government to design curricula, develop evaluation schemes, collaborate with the community, manage teachers, staff, and physical facilities, and adapt innovation by synergizing local and global knowledge systems to create curricular spaces. Likewise, among the studies that connect the harmonious learning environment, Dhungana (2022a) investigated the continuous professional learning journey alongside basic-level teachers at a public school in Kavre, Nepal, aiming to create a harmonious learning environment for all students.

On the world stage, economic crises in recent years because of the war between Russia and Ukraine (Since February 2022) and Israel and Hamas (Since October 2023) and, among other fronts, give rise to the shortcomings of resources in the regime of capitalist globalization (De Munck, 2020; Sklair, 2020). Capitalist globalization has been a key driver of the changing relationship between political (termed as the power elite) and economic fields (Schneickert, 2018). Such crises have gained academic attention throughout the world. Even economic rationalism is likely to advocate market-oriented reform in the education system by expecting high returns from educational sector investments without looking into its social and moral values (Dahal, 2024b), thus missing community orientation, as Gandhi advocates. The privatized education system of Nepal tends to promote monolingualism by prioritizing English as the primary language of instruction. This emphasis on ‘English Capitalism’ often sidelines local languages and cultures, reducing the use and proficiency of native languages among students. Consequently, the linguistic diversity of Nepal is at risk of being diminished. It rejects diversity in knowledge and practice, representing the ideals of economic rationalism, thereby weakening the public good of education.

Educational policies in Nepal are largely developed to serve the vested interests of power elites without seriously looking into our realities and needs, much akin to the notion of comprador intelligentsia that works in favor of global power and undermines the *locals* (Luitel, 2009; Dhakal, 2019). Although Nepal embraced a federal system with some authority over the local government, the elitist influences in Nepal's education system (and mathematics education) might further restrain the developed perspectives and models grounded in the Nepali contexts.

These influences are somehow reflected in students' educational experiences across the curriculum, pedagogy, assessment in general, and educational experiences from school to university level. These educational experiences were explored in my and others’ master’s, MPhil, and PhD research studies to be negative (see Dahal, 2013; Dahal, 2017; Dhungana, 2022a; Sharp et al., 2020; Shrestha, 2018; Shrestha & Luitel, 2019) across mathematics education. This is likely due to the largely disengaged nature of educational processes across different grades, pedagogy, and assessment. Addressing such a problem demands exploring ways of developing *relations between schools and communities for an engaged educational process* (Lampert, 2020). With this gap, many students were unsatisfied with their achievements at all levels (Poudel, 2016). Practices related to curriculum development, pedagogy, and assessment have often been encouraged to be implemented uniformly across all levels of education. This 'one-size-fits-all' approach means that the same methods and standards are applied to all students, regardless of their needs, backgrounds, or learning styles. While this can simplify implementation, it may not address the diverse needs of all learners, as expressed in the poetic form in the adjoining box, potentially leading to gaps in education quality and effectiveness (Cloitre, 2015; Jones, 2017; Pant, 2015; Paudel et al., 2023).

Freire would weep! Where was the critical cry?
The *"banking"* model passed the question by.
No challenge to the taken-for-granted assumption,
Just exams to pass, then seek to know no more.
Creativity was stifled, thinking turned to stone,
The innovations are left unsolved.

Schubert whispers: Curriculum's a stream!
Not static print but action, thought, and dream.
A journey map, not a cage! Where flows converge—
Where Health, Heritage, and Fields of Growth emerge!
Multidisciplinary rivers meet wide,
Interdisciplinary oceans where solutions ride!

Swaraj self-rule's potent call!
Devolve the power, and let local wisdom stand tall!
Federal promise now in reach,
To break the comprador's elite-choked speech—
The "English Capitalism" pushing tongues aside,
While global market forces falsely guide.

Mezirow stirs! Transformative sparks ignite!
Through reflective action, challenge wrong with right!
Dismantle walls where Mathematics lies cold,
Decontextualized, a story left untold.
STEAM beckons! Arts infuse the Science core,
Tech, Engineering, Math—one world, not four!

Ollenburg's participatory sight
Demands we shape the future, bold and bright:
"What *could* our learning be?" the children ask,
In gardens grown from this emancipating task.
Not "one-size-fits" the vibrant Nepali soul,
But diverse paths toward a common goal.

Nevertheless, the *pedagogical process at school must produce innovators* (e.g., learner agency and autonomy, inquiry-based and experiential learning, collaborative and reflective practice), focusing on inclusive and participatory methods for envisioning and creating desirable futures (Ollenburg, 2019). However, the one-size-fits-all approach to educational practices in Nepal has largely led to below-average achievement at all levels. As a result, many stakeholders blame others for their below-average achievement, as if they are not a part of it, with a transformative mindset. Thus, one of the research agendas guides me towards *exploring ways of developing innovative pedagogical practices in mathematics education* within the participatory design research for future studies is seen as an approach to shape the newer generation of research epistemologies, essential for expanding fundamental knowledge of learning and development (Bang & Vossoughi, 2016; Inayatullah, 2013).

Similarly, *empowering teacher professional development initiatives is needed for incorporating different forms of knowing to counteract* victim-blaming tendencies that exist in educational practices (Gracia, 2014) without questioning the underpinning practices of the system and people at the giving and/or receiving end (Dahal, 2019). Educational practices in Nepal have been increasing dissatisfaction on the receiving end day by day (Pant, 2019). This situation may demand visionary *leaders in schools across mathematics education for* an empowering and authentic educational process through a multidisciplinary to transdisciplinary approach to indoor and outdoor learning experiences (e.g., STEAM approaches). In addition, educational services are treated with a business-as-usual attitude among the stakeholders, which lacks deep and meaningful engagement upon any issues (Kamusella, 2016; Luitel, 2017), which encourages the disempowering belief system such as teaching, learning, assessment, and integrating innovation in pedagogical processes (Pant, 2015; Rao et al., 2009).

A large number of students from school to university suffer from failure in their lives even after they graduate from any level (Gurung, 2022). They may be nurtured from school education to be successful in their life by *synergizing multiple knowledge systems inquiry is needed.* This can be done by balancing the affective, cognitive, and somatic dimensions (DaCosta et al., 2020; Dahal, 2022b; Dahal, 2022c; Inan & Inan, 2015) in school education. Equally, there is a need for discourse on key values, beliefs, and assumptions for well-being, active citizenship, inclusion, and empowerment in the present situation to offer humanized education. The system/culture, process, and individual actors are to be engaged in the transformation process as viewed by an activist approach (Dahal & Luitel, 2022; Dahal et al., 2019a; Vianna & Stetsenko, 2014).

Mathematics education often needs an approach that integrates principles of transformative STEAM education (e.g., critical reflective practices, post/disciplinarity, community orientation, and (w)holism). This inquiry addresses the gap in the narrowly conceived notion of mathematics education (curriculum as subject matter, pedagogy of transmission, professional development as external engagement, and teacher leadership as an insignificant phenomenon by envisioning a STEAM-based mathematics education incorporating multidisciplinary, interdisciplinary, and transdisciplinary designs for learning and teaching. Likewise, the goal of this inquiry is to create a transformative learning environment that nurtures creativity, critical thinking, and problem-solving skills, bridges the gap between theory and practice, promotes interdisciplinary learning, and prepares students to tackle glocal challenges.

Purpose of the Inquiry

The purpose of this inquiry is to develop the vision for STEAM-based mathematics education in Nepal. The vision aligned with transformative curriculum spaces, engaged pedagogy, transformative teacher professional development, and reflective teacher leaders. The vision seeks to integrate school and school community collaboration in fostering an engaging pedagogical approach to mathematics education and/or classrooms in the areas of school and school community involvement in developing transformative curriculum spaces, engaged pedagogy, transformative teacher professional development, and reflective teacher leader.

Inquiry Questions

Based on the stated inquiry problem and the purpose of my inquiry, the following questions emerged for further exploration (overarching and subsidiary).

Overarching Inquiry Question

1. How do contextual and universal perspectives contribute to envisioning the transformative STEAM-based mathematics education in Nepal?

Subsidiary Emerging Inquiry Questions

a) How have mathematical curricular spaces been developed via the synergy of localization and globalization (i.e., glocalization) for producing innovative citizens?
b) How are engaged pedagogical processes practiced and envisioned in the school mathematics classroom?
c) In what ways have change-driven teacher professional development initiatives around school mathematics been inclusive to both local and global perspectives?

d) How has the leadership development process (teacher as a change agent and reflective teacher leader) been in place in areas of school mathematics education?

Significance of the Inquiry

To underline the significance of my inquiry, I have portrayed it across five dimensions: (1) philosophical, (2) curriculum, (3) pedagogy, (4) assessment, and (5) teacher education.

Philosophical

Philosophically, this inquiry is grounded in a dialectical inquiry of transformative STEAM-based mathematics education, examining its axiological, ontological, and epistemological foundations. Drawing upon Habermas' theory of emancipatory interest and Freirean critical pedagogy, it aims to transcend instrumental rationality by promoting autonomy, responsibility, and conscientização, a critical awakening of both self and society. The recursive process of reconceptualizing self-metaphors (McVicker & Walker, 2020) functions as a hermeneutic tool to reflect critically on the relationship between Dharma (e.g., moral duties) and Karma (e.g., actions), positioning the researcher-practitioner as both the subject and object of transformative praxis. By integrating Gandhian Swaraj (self-rule) with Mezirow's transformative learning theory, my inquiry critiques unhelpful neoliberal educational paradigms, advocating for a lifeworld-centric epistemology where knowledge production is co-constituted through dialogic engagement with individual self, relational selves (Tat-Twam-Asi, which means *you* are *that*), and universal self via my critical friends and inquiry participants. This philosophical stance emphasizes educational research and practice aiming at holistic meaning-making as a teleological endeavor, bridging Vedic and Buddhist wisdom and Western critical theory to reimagine STEAM education as a domain of emancipatory potential.

Curriculum

By proposing a "living curriculum" model that contextualizes mathematical concepts within technological, ecological, and sociopolitical systems—such as teaching geometry through architectural design, this inquiry envisions mathematics curricula through a STEAM lens, advocating for transdisciplinary frameworks that dissolve artificial boundaries between art, science, and ethics. The curriculum integrates Habermasian knowledge-constitutive interests (technical, practical, emancipatory) by pairing algorithmic proficiency with a critical discourse on equity, such as data justice in AI, subscribing to the Schubert (1986) curriculum metaphors, namely, curriculum as content or subject matter, curriculum as experience, curriculum as currere, curriculum as an agenda for social reconstruction, curriculum as a program of planned activities, curriculum as intended learning outcomes, curriculum as cultural reproduction, and curriculum as a process. It also synergizes local epistemologies, like numeracy practices, with global standards to foster cultural pluralism. Thus, this inquiry emphasizes collaborative curriculum design, involving teachers, students, and community stakeholders in co-developing units that address the National Curriculum Framework of Nepal and the Sustainable Development Goals of the UN. However, it critiques static assessment regimes, advocating for dynamic, project-based evaluations that measure creativity, collaboration, and ethical reasoning.

Pedagogy

Pedagogically, this inquiry advocates for a critical-constructivist approach to STEAM education, where mathematics is taught as a dialogic process of inquiry rather than a fixed body of knowledge. It employs Freirean problem-posing methods, encouraging students to deconstruct mathematical "texts" (e.g., algorithms, geometric principles) through power, identity, and justice lenses. Metaphorical thinking (e.g., reimagining equations as narratives) and arts-based methods (poetry, visual modeling) are used to democratize diverse learners' access. It flattens teacher-student hierarchies through participatory future studies (Ollenburg, 2019), transforming classrooms into laboratories for co-designing speculative solutions to global challenges (e.g., gamifying algebra to simulate urban planning). The pedagogy integrates the transformative praxis cycle—reflect, act, evaluate, revise—to cultivate metacognitive agility (Luitel & Dahal, 2020). Importantly, it demonstrates how educators can use "critical friendships" (Twam as relational selves) and peer observation to iteratively refine their practice iteratively, fostering a culture of collaborative vulnerability.

Assessment

This inquiry challenges conventional assessment procedures by proposing a triangulated model for evaluating transformative STEAM education, which combines performative assessments, dialogic portfolios, and critical peer reviews. Performative assessments explore authentic tasks like designing a community solar grid (applying geometry, physics, and ethics). Dialogic portfolios integrate poetry and visual art to document metacognitive growth through multimodal reflections. Critical peer reviews create structured feedback loops among students, teachers, and community stakeholders. Thus, assessment is considered a process over product, measuring competencies such as collaborative problem-solving, ethical reasoning, and adaptive creativity, drawing from Habermas' communicative rationality. The inquiry also introduces 'rubrics' that align with Freirean conscientização, assessing learners' ability to critique and reimagine sociotechnical systems (e.g., auditing bias). For teachers, participatory self-assessment tools—such as collaborative approaches—replace standardized evaluations, fostering a culture of iterative, equity-focused improvement.

Teacher Education

This inquiry attempts to redefine teacher education as a continuum of transformative praxis, blending self-study methodologies with communal knowledge-sharing. It positions educators as *bricoleurs* who critically adapt glocal STEAM frameworks to local contexts—e.g., using traditional approaches of Nepal *mandala* art to teach symmetry or fractal geometry. Central to this is the recursive use of self-metaphors (McVicker & Walker, 2020), where teachers interrogate their identities as 'boundary-crossers' between disciplines, cultures, and ideologies. Further, professional development can be reimagined through Mezirow's transformative learning phases, with workshops structured to trigger disorienting dilemmas (e.g., confronting biases in algorithmic bias) followed by reflective discourse. For strategies such as co-working for pedagogical innovations that challenge technocratic paradigms, this inquiry outlines a mentorship ecosystem that novice teachers apprentice with critical friends and veteran practitioners. Hence, by integrating participatory approaches into licensure requirements or decentralizing curriculum authority to school communities, the focus is on cultivating *teacher-leaders* who can advocate for paradigm shifts in pedagogical innovations.

Delimitation of the Inquiry

My inquiry is confined to myself, my four participants, and a critical friend subscribing to the Swa-Twam-Tat inquiry, inviting the readers based on my PhD studies and beyond. Here, I portray my vision of STEAM-based mathematics education in the area of developing an engaged and dynamic curriculum process, a pedagogical process conceived and implemented for producing innovators, enabling teacher professional development, and a reflective leadership development process. Swa-Twam-Tat inquiry is an alternative research methodology that is proposed to integrate the individual self (Swa), relational selves (Twam—research participants and a critical friend), and universal self (Tat—readers) and beyond. So, in my inquiry, there were two types of field text: narratives, voices, and reflective notes—collected and generated with critical self-reflection. My conversational field text, narratives, voices, and reflective notes were collected and generated, followed by a meaning-making process through dialectical, narrative, metaphorical, poetic, and visual logic and genres (Dahal & Luitel, 2022; Gubrium & Holstein, 2003; Luitel, 2009) with myself, four participants, and the critical friend. The process was carried out back and forth for multiple rounds before, during, and after the discussion, as Ākhyāna writing as the process of inquiry to capture the contextual and universal perspectives in my inquiry. I spent two years and six months generating field text, narratives, voices, and reflective notes, and the next year, I generated the narratives, voices, and reflective notes for my PhD as a field engagement. In some cases, the narratives, voices, and reflective notes generated aligned with my previous degrees—a master's in 2013 and an MPhil in 2017.

My Theoretical Referents and Perspectives

In my inquiry, meaning-making processes of the field text, narratives, voices, and reflective notes were collected and generated by myself, four participants, and a critical friend with the ethos of Ākhyāna analysis. The Ākhyāna analysis is a method of inquiry to examine, evaluate, and analyze the field text, narratives, voices, and reflective notes for meaning-making from the narratives—stories, or a collective of stories. In this writing process, theoretical understanding for generating, interpreting, and meaning-making as lenses to view the world (Dahal & Luitel, 2022; Pant, 2019) to interpret and critique is not free from a narrowly conceived theoretical and/or conceptual framework. Hence, I decided to use transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), critical pedagogy (Freire, 1970), curriculum images and metaphors (Schubert, 1986), Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019) as my theoretical referents and/or perspectives.

Transformative Learning Theory

Transformative learning theory in my inquiry offered me the space to reflect critically on ongoing actions for change. These spaces allow me to make sense of myself, my research participants, and a critical friend's experiences with the world from subjective perspectives. With the above ethos, Mezirow (1981) describes transformative learning for the research as:

> The emancipatory process of becoming critically aware of how and why the structure of psycho-cultural assumptions has come to constrain the way we see ourselves and our relationships, reconstituting this structure to permit a more inclusive and discriminating integration of experience and acting upon new understandings. (pp. 6-7)

In this line, I tried to make sense of myself, my research participants, and my critical friend's various professional ups and downs by reflecting critically on the underpinning values and beliefs while envisioning the transformative STEAM-based mathematics education. The meaning-making process of my inquiry is unique and changeable (Mezirow, 1991) as the research itself is a learning process of constructing and appropriating new and revised interpretations of the meaning of the field text, narratives, voices, and reflective notes. This happened for various reasons: truths, values, feelings, needs, desires, critical worldview, and frames of reference (Taylor, 2017). The frame of reference is my performance with reflections on my experiences, along with myself, my research participants, and my critical friend. In addition, research as transformative learning, in my inquiry, knocked on the door for new epistemological spaces for me and my research participants, and the critical friend invited the readers to examine the cultural situatedness of the practices and resonate with the emerging theories of experiential learning, dialogical learning, and inquiry learning (Taylor, 2013). In the research process, the central inquiry is, how can I, my research participants, and my critical friends engage in transformative learning? Transformative research involves critically examining one's own (and others') personal and professional values and beliefs, which shape a particular interpretation (Mezirow, 2000; Taylor et al., 2012). In critically examining the research process, reflection gives rise to understanding and developing the meaning. Reflection involves critiquing the assumptions and/or problem-solving, which emphasizes understanding more and learning better (Mezirow, 1991). So, my inquiry aligns with transformation rather than assimilation (Freire, 1970). In this context, transformative learning helped me and my research participants, and a critical friend in preparing to become a critical, self-reflective citizen by critiquing the taken-for-granted social norms and making ethical judgments towards equity, justice and democratic practices (Pant, 2019), while envisioning STEAM-based mathematics education for Nepal.

Knowledge Constitutive Interests

Habermasian knowledge constitutive interests (Habermas, 1972) was another theoretical referent that offered me, my research participants, and a critical friend the ability to describe a human ability to pursue goodness or well-being through knowledge and/or reasoning. In my inquiry, among three knowledge constitutive interests—technical, practical, and emancipatory (Habermas, 1972), I believe in the emancipatory interest. The emancipatory interest provided me, my research participants, and my critical friend with the grounds to challenge taken-for-granted assumptions to envision STEAM-based mathematics education. My inquiry was also the process of transforming myself, my research participants, and a critical friend, and other readers towards critically conscious mathematics educators; hence, the emancipatory interest enabled me and my research participants and a critical friend to contribute to developing responsibilities and awareness about envisioning transformative STEAM-based mathematics education. In doing so, emancipatory interest further enabled me to develop a counter-hegemonic vision of STEAM-based mathematics education (Pant, 2019). Thus, I deployed an emancipatory interest to develop an awareness of the false consciousness of my life, my research participants, and my critical friend while developing the vision of STEAM-based mathematics education for Nepal.

Critical Pedagogy

Critical pedagogy is another supportive theoretical referent of my inquiry. Critical pedagogy (Freire, 1970) offered me, my research participants, and a critical friend a space to challenge cultural, historical, and apolitical views of STEAM-based mathematics education. Likewise, conventional mathematics education urged learners to perform within the narrowly designed official text (prescribed textbook). In this line, in my inquiry, critical pedagogy is a part of socio-cultural approaches. Socio-cultural approaches across personal empowerment and social transformations are inseparable (Freire, 1970). Equally, as a possible agent of social change, I am aware of the social and political practices in which we are. Eventually, this process enables me, my research participants, and the critical friend to "awakening" experiences to engage in an authentic dialectical process and gradually move on to identifying broader meaning (Freire, 1970) by challenging the banking model of education and one-size-fits-all pedagogical approaches. In this way, critical pedagogy, as one of the theoretical referents, helped in my inquiry by embracing critical consciousness.

Critical pedagogy further encouraged and enabled me to account for lived experiences. The ethos behind this was to capture the educational lifeworld's key moments through multiple expressions such as dialectical, narrative, metaphorical, poetic, and visual logic and genres. I intend to explore conflicting ideas and their resolutions to reveal deeper truths, subscribing to the dialectical genre. I have crafted a story through seamlessly integrating events and characters into an engaging and structured plot using the narrative genre. The metaphorical genre allows me to compare concepts through figurative language, which results in deeper meanings and insights. I chose the poetic genre because its rhythm and evocative language allow me to express emotions and ideas beautifully. Through visual elements, I use images to convey messages and concepts within the visual genre's space for communication. Using the logic genre enables me to depend on structured reasoning and evidence to build clear and persuasive arguments. This dimension of the research process might enable my research participants and the critical friend to construct a vision of life-affirming and meaningful mathematics education as an empowering device (Luitel, 2012) termed transformative STEAM-based mathematics education. This process gave rise to considering the lived experiences of students, teachers, and teacher educators to reflect on myself, my research participants, and the critical friend to values, beliefs, thoughts, and practices. Likewise, change can be conceived via heightened consciousness; thereby, change entails a multi-pronged—approach that tackles a problem from multiple angles simultaneously to ensure comprehensive solutions, and a multi-dimensional—perspective considers various aspects and layers of a subject to provide a thorough understanding (McLaren & Kincheloe, 2007) while envisioning transformative STEAM-based mathematics education for Nepal.

Curriculum Images and Metaphors

Schubert's 1986 book, Curriculum: Perspective, Paradigm, and Possibility, explores different metaphors and images to describe curriculum. It covers traditional views like curriculum as subject matter and planned activities, as well as progressive perspectives such as curriculum as experience and social reconstruction. These insights provided a foundation for envisioning curriculum spaces in STEAM-based mathematics education. In my thesis, I employed Schubert's (1986) curriculum images and metaphors as a perspective to analyze how educational practices are conceptualized and enacted critically. I interrogate the implicit values and assumptions that shape pedagogical decision-making by engaging with metaphors such as curriculum as a journey or a garden. I argue that these metaphors reflect student-centered, growth-oriented, or structurally constrained ideological orientations. It also molds how educators design learning experiences and negotiates classroom power dynamics. I explored how the "journey" metaphor prioritized exploration and agency, while the "garden" metaphor emphasized nurturing and organic development, systemic complexity, and institutional barriers through this perspective. I revealed tensions between curricular ideals and lived realities by grounding my analysis in those images, advocating for a reflexive approach to curriculum design that acknowledges metaphor as a tool for critique for reimagining equitable educational structures.

Swaraj Perspective

Swaraj perspective is another theoretical referent of my inquiry. This theoretical perspective allows me to envision an alternative society as a local indigenous system within the mathematics education community with the ethos of self-rule and autonomy to exercise their decisive power for incorporating and exercising innovation in teaching and learning (Gandhi, 1909; Mohanty, 1991). These processes form an alternative society within a local indigenous system that transforms the same society to the next level for better practices within the mathematics education community. This process helped me develop the vision of STEAM-based mathematics education in Nepal. However, *Swaraj* is the foundational text of the Gandhian worldview (Jennings, 2020). Primarily, *Swaraj* deals with two issues—(a) a critique of modernist civilization and (b) the nature and structure of *Swaraj* and the means and methods to achieve it. Its central ideas are the malaise of modern civilization, the ‘English’ educational system in Gandhian terms, the *Swaraj,* and the vision of an alternative society. In my inquiry, *the vision of an alternative society* is relevant because it deals with the broad contours of an alternative society within a local indigenous system as a new civilizational framework in a rudimentary form, with the community practice of mathematics education. These processes further pave the path for developing the vision of STEAM-based mathematics education. Likewise, Gandhi (1909) defines it as a “mode of conduct which points out to man the path of duty” (p. 54). He further adds that moral behavior is nothing but to reach ‘mastery over one’s mind.’ Its core values are limited to self-indulgence in terms of luxuries and pleasures, emphasis on the ancestral profession, rural life, curbing unnecessary competitiveness, and preference for small-scale technologies and decentralized polity. This gives rise to the fact that modern societies are moving away from these old good values. This philosophical significance further explores “the concept of *Swaraj*. Gandhi laid down his philosophy of life in this work, which defines the concept of self-rule. In this way, an attempt is made to show how *Swaraj* harmonizes political and economic freedom with spiritual freedom” (Panda, 2020, pp. 421-422) in an educational setting for developing the envision for STEAM-based mathematics education in/for Nepal as a local indigenous approach.

Participatory Future Studies

With the slogan that the future is not given but created, I have taken the support of participatory future studies (Bell, 2017; Ollenburg, 2019) as another theoretical referent of my inquiry. Ollenburg (2019) offered a way of merging approaches of participatory futures research with the research structures through design to apply processes and methods from design in the research process. So, participatory future studies are foundational in my inquiry for myself, my four research participants, and a critical friend for improving the interaction between key actors and anticipatory policymaking (Ollenburg, 2019) for humanizing STEAM-based mathematics education for citizenship education. Citizenship education integrates the principles of civic responsibility and social engagement into teaching science, technology, engineering, arts, and mathematics, fostering informed and active participation in society. Likewise, this perspective emphasizes the importance of both the production and "supply" of innovation and the "demand," as signaled in the views of learners and/or participation, while envisioning transformative STEAM-based mathematics education for Nepal. This inquiry envisions a collaborative approach where roles are clearly defined among myself, my four research participants, and a critical friend, ensuring transparency and active involvement of participation-oriented researchers for the critical discourse of the community—students, teachers, and schools and the community. The broader inclusion of diverse participants and their perspectives is seen to expand the visibility of the future and promote learners' and practitioners’ engagement with it. Participatory design research for future studies is seen as a method that can shape a newer generation of research epistemologies, essential for expanding fundamental knowledge of learning and development (Bang & Vossoughi, 2016). Overall, participatory future studies are highlighted as a process that can promote social change and help learners and practitioners develop (Dhungana et al., 2022) while envisioning transformative STEAM-based mathematics education in Nepal.

To differentiate among the concepts of transformative learning theory, knowledge constitutive interests, critical pedagogy, Swaraj perspective, and participatory future studies, I have attempted to highlight the foundational aspects, key principles, and objectives of each framework and/or perspective in Table 1 on the next page.

Table 1

Comparison of Theoretical Concepts, Foundational Aspects, Key Principles and Objectives, and Alignments

Concept/Author	Foundational Aspects	Key Principles	Objectives	Alignments
Transformative Learning Theory (Mezirow, 1991)	Focus on the process of critical reflection leading to a change in personal beliefs and perspectives.	Critical reflection, dialogue, and perspective transformation.	To facilitate personal growth and perspective change through critical reflection on experiences.	Research as/for professional development
Knowledge Constitutive Interests (Habermas, 1972)	Theory on how human interests shape knowledge production, focusing on technical, practical, and emancipatory interests.	Communication is free of domination and understanding of social realities.	To understand and critique society, aiming for emancipation from unjust power structures.	Mathematics community

Critical Pedagogy (Freire, 1970)	Emphasis on education as a practice of freedom, challenging oppression, and empowering learners.	Problem-posing education, consciousness-raising, liberation from oppression.	To transform society by educating individuals in a way that fosters critical consciousness.	School and community are involved in developing engaged pedagogical processes
Curriculum images and metaphors (Schubert, 1986)	Traditional views like curriculum as subject matter and planned activities, as well as progressive perspectives such as curriculum as experience and social reconstruction	Analyze how educational practices are conceptualized and enacted critically	How educators design learning experiences and negotiate classroom and power dynamics advocating for a reflexive approach to curriculum design that acknowledges metaphor as a tool for critique for reimagining equitable educational structures	Curriculum spaces

Swaraj Perspective (Gandhi, 1909)	Advocacy for self-rule and a return to traditional values in opposition to colonialism and modernization.	Non-violence, self-sufficiency, moral and spiritual development.	To achieve political and personal self-rule and promote a society based on ethical principles for autonomy.	Formation of indigenous local system
Participatory Future Studies (Ollenburg, 2019)	Focus on inclusive and participatory methods for envisioning and creating desirable futures.	Inclusivity, co-creation, and future-oriented action.	To democratize the process of future-making, enabling diverse learners to shape their futures.	Envisioning and creating futures, social change and help learners and practitioners develop

This comparison in Table 1 shall provide a snapshot of how each referent and/or perspective views learning, knowledge, and societal change while envisioning STEAM-based mathematics education. So, Table 1 compares the theoretical foundations, principles, and aims of each referent and/or perspective and their alignments for contribution. While each has its unique focus—personal transformation, the critique of knowledge production, educational liberation, ethical self-governance, or inclusive future planning- they all contribute to broader discussions on learning, social change, and envisioning futures.

Transformative learning theory (Mezirow, 1991), knowledge constitutive interests (Habermas, 1972), critical pedagogy (Freire, 1970), Swaraj perspective (Gandi, 1909) metaphorically as a local Indigenous system, and participatory future studies (Ollenburg, 2019) are the theoretical referents and/or perspectives in my inquiry. They helped me to generate meaning from the field texts and lived experiences of myself, my four participants, and a critical friend, inviting the readers.

In general, the meaning-making process is not limited to field texts and lived experiences but can be constructed by interpreting the phenomenon under study with different philosophical considerations. Therefore, to generate the meaning from the filed text and of myself, my participants, and my critical friend, I have used Ākhyāna portrayal as a method of inquiry for meaning-making from the narratives, such as stories in transformative, philosophical, and performative ways (Dahal, 2024b; Denzin & Giardina, 2022) while envisioning the transformative STEAM-based mathematics education.

Organization of the Inquiry

This thesis is framed into eight chapters. Phase I presents three chapters: Chapter I, Chapter II, and Chapter III. In Chapter I, I explored the need to inquire into the what, the why, and the how of an emergent and relevant pedagogical framework and/or approach to transformative STEAM-based mathematics education as my inquiry agenda. I included positioning myself in the inquiry and framing the research problem, purpose, and research questions. Chapter II is crafted to conceptualize STEAM education and STEAM-based mathematics education. While conceptualizing, I reviewed STEAM education: philosophical perspectives, fallible and absolute nature of STEAM education, economic rationalism to STEAM education, Contextualism and universalism in STEAM education, integrated learning: multi/inter/transdisciplinary approaches, transformative STEAM education as/for Mokshā (Liberation), education for innovation, leadership within and without the context: reflective teacher leader, glocal thinking about mathematics, empowering curricular spaces, reviews of contemporary research studies and research trends in STEAM education. Near the end of Chapter II, I articulated the theoretical/conceptual orientation of my Swa-Twam-Tat inquiry. Chapter III presents the overall roadmap of my Swa-Twam-Tat inquiry. Likewise, Chapter III endorses my research methodology while undertaking this Swa-Twam-Tat inquiry by enabling me to interrogate the inquiry, which might be the roadmap for paving the research path. For this inquiry, I have included, namely, philosophical assumptions, Gyāna Pranāli design space, Swa-Twam-Tat inquiry as a research methodology, research as/for transformative learning for Mokshā/liberation, research space, Ākhyāna writing as the process of inquiry, ensuring the quality standards and ethical consideration.

In phase II, I explored the Swa-Twam-Tat inquiry in chapters IV, V, VI, and VII based on my overarching and subsidiary emerging research questions, aligning with my methodological roadmap, theoretical referents, and perspectives.

In phase III, I reflected on learning and realizations from my Swa-Twam-Tat inquiry within Gyāna Pranāli design space of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda. Chapter VIII explored my envisioned STEAM-based mathematics education toward understanding and implementing new world views and how to make a good shift to move forward toward academic excellence and a sustainable education and/or research program.

Chapter Summary

In this chapter, I framed the agenda of my Swa-Twam-Tat inquiry. In doing so, I articulated the context of the inquiry by retelling my journey—how I initially conceptualized transformative STEAM-based mathematics education. Framing the research problem is somewhat risk-taking and challenging in my Twa-Twam-Tat inquiry. I framed the research problem to envision the contextual and universal perspective of STEAM-based mathematics education in/for Nepal. Likewise, this chapter covered the inquiry's context, framing the research problem, purpose of the inquiry, research questions, significance of the inquiry, delimitation of the inquiry, my theoretical referents, organization of the thesis, and chapter rundown. In the next chapter, I have conceptualized the transformative STEAM-based mathematics education across recent and relevant literature.

CHAPTER II
CONCEPTUALIZING STEAM-BASED MATHEMATICS EDUCATION

I proclaim that this is not a formal literature review chapter, as I have done my review when and where it is needed. Therefore, this chapter positions me in the debates and perspectives while conceptualizing STEAM-based mathematics education. So, this chapter is thematically organized into twelve themes: (1) STEAM education: philosophical perspectives; (2) fallible and absolute nature of STEAM education; (3) economic rationalism to STEAM education; (4) Contextualism and universalism in STEAM education; (5) integrated learning: multi/inter/transdisciplinary approaches; (6) transformative STEAM education as/for Mokshā (Liberation); (7) education for innovation; (8) leadership within and without the context: reflective teacher leader; (9) glocal thinking about mathematics; (10) empowering curricular spaces; (11) reviews of contemporary research studies; and (12) research trends in STEAM education. Near the end of this chapter, I have constructed spaces for STEAM-based mathematics education in my inquiry by illustrating the theoretical/conceptual orientation of my inquiry and the chapter summary.

STEAM Education: Philosophical Perspectives

I come to view that the philosophy of STEAM education is rooted in integrating disciplines to cultivate a holistic learning experience that nurtures creativity, critical thinking, and problem-solving abilities (Guyotte, 2020). When connected with my inquiry, this philosophy gains a deeper dimension. As a researcher, I encouraged myself to recognize and develop unique curriculum spaces, engaged pedagogy, transformative teacher professional development, and reflective teacher leadership, fostering a sense of personal identity and purpose. Another aspect emphasizes collaboration and empathy, highlighting the importance of teamwork and understanding and appreciating diverse perspectives, which are crucial in interdisciplinary projects and real-world problem-solving. Finally, the readers' component inspires me to seek interconnected truths and universal principles that transcend individual disciplines, promoting a comprehensive understanding of the world.

In STEAM fields where art and science meet,
I seek the truths that cross each measured line,
To teach, to lead, to shape with hands and heart.

As expressed in the adjoining box, I advocated for an educational approach that not only imparts technical knowledge but also cultivates self-awareness, social responsibility, and a profound quest for universal understanding, ultimately preparing students to navigate and contribute to an increasingly complex and interconnected world.

For instance, I was unaware of STEM and STEAM education until I seriously delved into it. While conceptualizing STEAM education, from literature and my continuous engagements in the STEAM field, I have realized that there has been advocacy about the need for STEAM 'programs' in our existing educational institutions. I understand and believe that STEAM is aligned with a transformative approach. It gives rise to traditional academic boundaries, effortlessly weaving together the STEAM field to promote curiosity and foster critical thinking skills for 21st-century learners. Implementing STEAM education empowers students like me to take risks, immerse themselves in experiential learning, tackle complex problems, collaborate with peers, and become creative and reflective leaders.

In my inquiry, the terms associated with the approach in STEAM education are "defined" firstly as lifelong learning and inquiry that includes multidisciplinary, interdisciplinary, and holistic approaches (Fawcett, 2013). Secondly, a project/problem-based inquiry focuses on integrating valuing, knowing, and doing. Thirdly, it is about multidisciplinary to transdisciplinary design, using problem-focused processes, sharing, and working together. Fourthly, it is also discipline-specific and beyond, such as science, technology, engineering, arts, and mathematics. Finally, content-specific refers to the facts, concepts, theories, and principles taught and learned rather than skills. I have realized that the need for skills is likely to be nurtured in school education in collaboration with the school and school community stakeholders. This gives rise to the need for STEAM teaching and learning in mathematics to engage the learners in indoor and outdoor learning activities. So, the STEAM education approach is likely to illustrate the nature of the relationship between contents, disciplines, multidisciplinary, interdisciplinary, and transdisciplinary instructional approaches, problem-based inquiry and research, and life-long holistic learning habits of mind for change and sustainability (Dahal, 2022b; Richard & Biffle, 2016). STEAM Education has emphasized transversal skills, which are not tied to any specific job, task, academic discipline, or area of knowledge are nurtured to be applicable in a wide range of situations and work environments. Although presented from a neoliberal perspective, these skills are increasingly sought after to help learners adapt to transformative changes and lead meaningful and productive lives. Examples include critical and innovative thinking, interpersonal skills (such as presentation, communication, organizational skills, collaboration, and teamwork), intra-personal skills (such as self-discipline, enthusiasm, perseverance, and self-motivation), global citizenship (such as tolerance, openness, respect for diversity, and intercultural understanding), and media and information literacy, which encompasses the ability to locate, access, analyze, and evaluate media content (Grizzle et al., 2014).

In this line, STEAM education shall extend the abilities of problem-solving, fearlessness, collaboration, and critical thinking by designing challenges and tactile skills that every learner needs (Maeda, 2013). These skills and abilities provide a holistic education that engages both sides of the brain (metaphorically), hands, and body, developing students' functional literacy across the curriculum and promoting STEAM pedagogy aligned with transformative education. Through the execution of STEAM pedagogy, students will get an opportunity to explore different concepts and learning processes through real-world activities to strengthen their strengths and understanding, which will help them overcome their weaknesses (Catchen, 2014).

In addition, the STEAM movement is essential in developing key skills such as self-reflection, communication, collaboration, creativity, and innovation in learners and bridging gaps in student learning (Naithram, 2014). While STEAM curricula are believed to give rise to students to be engaged, empowered, and think about their education's real-world applications (Lamichhane & Dahal, 2022; Jackson, 2015), as an outcome, STEAM Education is for tackling the problems and crises of the 21st century. These talents will encourage learners to question, reflect, and guide innovation-oriented issues with collaboration across the school and/or other stakeholders (Dahal, 2017).

Today, many educators and even I believe that the boundary between science and the humanities should be broken down (Pant et al., 2023). Since 2011, interest in STEAM education has grown in Korea; recently, some initiatives have been noticed in Nepal's central, provincial, and local governments, NGOs, and INGOs. In the same alignment, I am observing that STEAM education pops up everywhere with a lot of possibilities, such as engaging students in problem-solving and connecting to project-based learning, communication, collaboration, creativity, and innovation, among others (Stroud & Baines, 2019), despite what STEAM education is. I see websites, blogs, journals, online journals, and books with "STEAM" education that are easy for teachers to access in urban areas, but are not contributing much to building equity and identity in students being offered the experience. In Nepal, STEAM education is posed as an approach to help all students connect with science, technology, engineering, arts, and mathematics. These subjects have been incorporated into the curriculum for grades 1-3, and integrated pedagogy has been adopted as STEAM pedagogy in the basic-level education system.

Additionally, when I reviewed the document under STEAM education in Australia, I found that scientists in Australia are calling for STEAM education to better engage students in STEAM-related career pathways. In contrast, STEAM scholars are advocating:

In the context of STEAM education, concepts connected to real-world activities that effortlessly connect theory with practical applications.

Box 4: STEAM Education Connections

> to produce graduates with creative and innovative abilities required for an increasingly advanced workforce. Thus, STEAM educators are being challenged to design curricula and pedagogies to develop students' disciplinary to transdisciplinary knowledge and skills as well as their abilities as critical consumers, creative and ethically wise citizens, innovative designers, good communicators, and collaborative decision-makers. (Taylor, 2015, p. 89)

Thus, considering that learning is holistic, integrative, and reflective of real-world complexity, the philosophical perspectives of STEAM education are based on the idea of those learning (Guyotte, 2020). Ethical inquiry examines moral principles and values to understand and resolve ethical dilemmas, guiding individuals and societies to make just and responsible decisions. These approaches posit that including art is essential for fostering critical thinking, innovation, and a deep understanding of diverse cultural and humanistic values. Thus, STEAM embodies the belief that education should cultivate technical competencies and the wisdom, empathy, and transformative capacity needed to navigate and improve an increasingly complex world, emphasizing interdisciplinary connections and encouraging learners to engage in reflective dimensions of learning.

Building on the above, this inquiry represents my effort to craft a vision for STEAM-based mathematics education. This vision aims to transform school mathematics for 21st-century teaching and learning, embracing a multidisciplinary to transdisciplinary approach. It seeks to create new knowledge that drives change and fosters sustainable educational practices for promoting citizenship education.

Fallible and Absolute Nature of STEAM Education

STEAM is an emerging model for educational purposes (Yakman, 2010), integrating science, technology, engineering, arts, and mathematics. However, this emerging framework has two natures: fallible and absolute. The fallible nature of STEAM education acknowledges its limitations, imperfections, and the contextual challenges it faces. So, the fallible nature of STEAM education is viewed from the ever-changing nature of disciplines. So, the STEAM education program can succeed only when available resources, training, and expert educators can integrate STEAM into the existing curriculum. However, as expressed in the poetic form in the adjoining box, the implementation of STEAM is frequently uneven; many educators lack the training or resources to effectively integrate the disciplines, resulting in fragmented and superficial learning experiences. Likewise, the assessment of STEAM outcomes also poses a significant challenge for the existing curriculum in Nepal because the traditional curriculum always focuses on testing the knowledge (c.f., interdisciplinary and creative skills, STEAM aims to foster). Indeed, STEAM education is blamed for the potential superficial integration in scientific and technical learning, as the conclusion of art shall be more symbolic than substantive. Underlining the need for thoughtful and well-supported integration, addressing the complexities and difficulties in implementing STEAM approaches for maximizing its benefits, embracing challenges as a learning tool, and conducting need-based research.

> STEAM seeks truth but stumbles still,
> Logic and art both bend to will,
> In flaws we grow yet dream our fill.

The absolute nature of STEAM Education could present STEAM disciplines as unchanging one. However, the absolute nature of STEAM education lies in recognizing that learning is inherently interconnected and human-centered. So, the learners cannot think critically and creatively in such unchanging disciplines. An engagement with an absolutist nature of discipline promotes conformity, reproduction, and routine problem-solving skills. These skills may be necessary for learners to understand and apply disciplinary knowledge. Thus, the absolute nature of STEAM education refers to its foundational principles and enduring relevance across educational, societal, and philosophical dimensions. Next, by connecting different fields, such as a STEAM education approach, with the absolutist nature of disciplines prepares the learners for the test, thereby promoting rote learning and leaving behind meaning-centered education. To prepare students to navigate and contribute to an increasingly complex and interconnected world, the absolutist nature of STEAM education may help develop disciplinary knowledge and skills that will be needed for them to apply in actual realization in STEAM disciplines.

With all of the above, the philosophy of STEAM education acknowledges the fallible nature of traditional disciplinary boundaries and the necessity of integrating STEAM to address complex real-world challenges. The absolutist nature of STEAM disciplines might be minimally used while applying disciplinary knowledge and skills in a holistic nature of STEAM education. While STEAM aims to break down absolutist academic silos of different disciplines, it also confronts the limitations of existing systems, such as the risk of weakening mathematical rigor or the difficulty in assessing interdisciplinary outcomes (Dahal, 2022b; Kim & Wilkinson, 2019). My inquiry emphasizes the fallibility of isolated knowledge systems, advocating instead for a holistic approach that balances self-awareness, collaboration, and universal ethical values (Guyotte, 2020). In my inquiry, I also feel that challenges include inequitable access to STEAM resources and the need to reconcile local identity with global educational trends (Pant et al., 2023; Luitel & Taylor, 2010; Luitel & Taylor, 2019).

Economic Rationalism to STEAM Education

Economic imperatives are the major drivers behind promoting STEM and STEAM curricula, as national and international policies discuss the need for a capable workforce for economic growth and globalized skills. Further, well-recognized as a powerful driver of national economic growth, STEAM lies at the heart of calls worldwide for educational reform and sustainability for the 21st century (Mengmeng et al., 2019), which could be helpful for the Nepali education system as well as the Nepali curriculum development process for implementing innovative and integrated STEAM pedagogy. Indeed, STEAM education programs are rationalized by their potential to equip learners with innovative skills and problem-solving abilities linked to emerging job markets.

However, overemphasizing economic rationalism, broader educational values are missing, and the focus is shifted to aligning the curriculum with market needs. Thus, these debates challenge the stakeholders to balance economic considerations with the goal of holistic education. Integrating the arts into STEM education is important to foster innovation and creativity. This integration can help balance essential human values and economic growth. However, ensuring that the educational experience remains holistic and inclusive is crucial, addressing both economic and social needs.

Federal and local governments in Nepal and NGOs invest in STEAM initiatives to cultivate a workforce capable of sustaining economic growth and social mobility (Pant et al., 2024). Economic rationalism also emphasizes transversal skills like critical thinking, collaboration, and technological literacy, which are essential for adaptability in evolving societies with demands for earning (Grizzle et al., 2014). Indeed, overemphasizing economic outcomes risks reducing education to vocational training, sidelining broader humanistic goals for promoting citizenship education (Taylor, 2015).

Contextualism and Universalism in STEAM Education

STEAM education is premised on integrating different subjects and/or fields to nurture interdisciplinary teaching and learning. So, contextualism in STEAM education focuses on teaching and/or facilitating different subjects in ways that are helpful and relevant to learners' lives for applications in present and future endeavors. This approach supports learners in seeing the connections among the different disciplines and understanding how they can be utilized to solve complex problems. Likewise, STEAM education can be applied across different contexts, cultures, and educational landscapes by maintaining contextualism-universalism dialectics (connection, collaboration, and synergy) in STEAM education. Emphasizing inclusivity and accessibility, learners with unique backgrounds can benefit from STEAM learning. Universal design for learning, cultural relevance, accessibility, and global collaboration are some aspects of universalism in STEAM education for creating inclusive and equitable learning platforms that empower all learners to succeed (Thoma et al., 2023).

On the whole, STEAM education navigates the interplay between contextual specificities, such as local needs and cultural relevance, and universal principles, including competencies requiring interdisciplinary orientation. In my context, as expressed in the adjoining box, STEAM integrates indigenous knowledge while aligning with global standards, as demonstrated by programs at Kathmandu University School of Education, Department of STEAM education via their master's, MPhil, and PhD programs (Dahal & Luitel, 2023; Pant et al., 2020). So, my inquiry attempts to bridge local-global gaps by addressing community-oriented learning issues like climate change through place-based projects (Bertrand & Namukasa, 2023). Additionally, transdisciplinary approaches contextualize and universalize truths that connect disciplines, fostering glocal citizenship (Guyotte, 2020; Luitel & Taylor, 2007).

> In every place, learners bring their world,
> Yet truths of science cross every land and hand,
> STEAM grows where roots and stars both stands.

Integrated Learning: Multi/Inter/Transdisciplinary Approaches

Transformative STEAM education is to bridge the disciplines via multi-, inter-, and trans-disciplinary approaches. Different subjects, such as math and art, are combined in a multidisciplinary approach to enhance problem-solving capabilities (Quigley et al., 2020). The interdisciplinary approach synthesizes techniques like coding and engineering to create real-world applications (Maeda, 2013). Through systems thinking, the transdisciplinary design goes beyond individual disciplines to tackle societal challenges, such as climate change and famine (Perignat & Katz-Buonincontro, 2019). Challenges may include maintaining academic rigor and coordinating stakeholder collaboration (Lamichhane & Dahal, 2022).

Governed by the principle of interconnectedness, the integrated curriculum in Nepal (CDC, 2019) posits that every element in the world is interdependent, with each existing about others. This curriculum integration is aligned with multi-, inter-, and trans-disciplinary. On the continuum of curriculum integration, the multidisciplinary approach is the least integrative, involving knowledge, processes, and skills from multiple disciplines through theme-based teaching. The current integrated curriculum of Nepal predominantly follows this multidisciplinary integration. For instance, a project conducted in an institutional school in Kathmandu centered around a 'kitchen garden.' This theme allowed the development of concepts and skills from various disciplines, including science (e.g., soil, plants, environment), mathematics (e.g., area, height, patterns, numbers, basic operations), engineering and technology (e.g., plot design, internet research), and arts (e.g., creating an appealing garden, writing poems or songs, painting, and fostering community spirit). These subjects are organized around a theme rather than an authentic problem (Wickson et al., 2006). However, this approach may not be helpful as it still allows for the predominance of separate disciplines. While this could serve as a starting point for STEAM education, it raises the question of how teachers can integrate real-world problems that students and the broader community face. The STEAM curriculum should feature interdisciplinary and transdisciplinary approaches. The interdisciplinary approach emphasizes common skills and concepts embedded in disciplines, where knowledge is socially constructed with multiple correct answers (Drake & Burns, 2004). This approach involves collaborative projects addressing specific real-world problems, encouraging students to create new knowledge across disciplines (Stock & Burton, 2011). The kitchen garden theme can be applied in interdisciplinary teaching by allowing students to ask questions across disciplines and addressing everyday issues like protecting the garden from predators or weather changes. This enriches students' problem-solving skills with real-world applications. The transdisciplinary nature of the STEAM curriculum represents a shift, focusing on real-world problem-solving through project-based and inquiry-based learning. Students develop life-affirming skills by applying interdisciplinary concepts in real-life contexts (Drake & Burns, 2004), often transcending disciplines to produce new perspectives (Gibbs, 2015), and solving authentic problems by fostering creativity, imagination, and critical thinking.

Transformative STEAM Education as/for Mokshā (Liberation)

Reflecting on my journey of conceptualization, transformation is all about the change processes that disrupt and block the flow of freedom in research and practice. These change processes may transform me and practitioners to become critically aware educational leaders. The transformation processes include the transformation on one-size-fits-all approaches of educational practices and solving the existing glocal crises. Next, transformative teaching and learning are the main wheels of transformative education. Transformative education helps learners perceive the world through a unique and ethical perspective, challenging and changing the status quo as a change agent. These processes uphold the current power relations. In response to the question, whose interests are being served? More so, Taylor and Taylor (2019) offered views on education for sustainable development such as:

> A transformative approach to curriculum development results in socially responsible STEM education. By integrating STEM and the arts, we can create interdisciplinary STEAM curriculum spaces for developing transformative pedagogies that help students develop their disciplinary knowledge/skills, awaken their creative self-awareness, enhance their moral/ethical and spiritual awareness, and empower them to practice environmentally responsible behavior. (p. 1)

Social responsibilities for glocally sustainable STEAM education are another discourse of transformative STEAM education that might enable us to envision future perspectives on preparing young people's knowledge and skills.

Likewise, the notion of inquiry and research is not limited to specific disciplines. The broader research concepts cover the humanitarian transformation of the habit of the mind for change, the transformative mindset, and sustainability. In this line, conventional research practices in mathematics education seem to be aligned for finding an inadequate response to the proposed research issues in multidisciplinary to transdisciplinary design. The scholars' discourse sought possible research and/or inquiry that might be helpful for covering the broader spectrum of research in mathematics education. With the above gap, this section explored how research can lead to the Mokshā or Liberation, covering aspects such as information, meaning, synthesis, tolerance, ethics, and self-consciousness. Mokshā refers to the liberation of achieving ultimate freedom and spiritual enlightenment in the inquiry process.

Transformative learning, a concept rooted in educational theory, aligns closely with the spiritual and philosophical goal of moksha (liberation) in Eastern traditions such as Hinduism, Buddhism, and Jainism. Both transformative learning and Mokshā emphasize thoughtful personal and existential change, leading to freedom from ignorance, suffering, and limiting beliefs. Starting with transformative learning, as Jack Mezirow theorized, involves critical reflection and self-examination that leads to a shift in one's worldview, beliefs, and assumptions. It is characterized by disorienting dilemmas, which are experiences that challenge existing perspectives. This process includes critical reflection, where individuals question and re-evaluate deeply held beliefs. Additionally, dialogue and discourse play a crucial role, as engaging with others helps explore new ideas. Finally, action and integration are essential, as applying new insights transforms one's life. Likewise, Mokshā refers to liberation from the cycle of birth, death, and rebirth (Samsara). It is achieved through self-realization, which involves understanding the true nature of the self (atman) and its unity with the ultimate reality (Brahman). Another key aspect is freedom from ignorance (avidya), where one overcomes illusions and misconceptions about reality. Detachment (vairagya) is also essential, as it involves letting go of attachments to material desires and ego. Finally, ethical living and compassion play a crucial role, as cultivating virtues such as truthfulness, non-violence (Ahimsa), and selfless service (Karma yoga) are integral to achieving Mokshā.

Mokṣaśāstra centers on pursuing Mokshā, or liberation, which is the ultimate goal of human life according to many Sanskriti and Eastern philosophical traditions. It involves the realization of one's true self and the transcendence of the cycle of birth and death. This path to liberation is marked by ethical living, self-discipline, meditation, and the cultivation of wisdom and detachment from material desires. These principles help individuals achieve inner peace and eternal bliss, free from the suffering and limitations of worldly existence. The essence of Mokṣaśāstra, when aligned with transformative learning research, emphasizes the journey toward self-realization and liberation through deep, reflective learning. It advocates for a holistic approach where learners critically self-reflect, challenge their beliefs, and embrace new perspectives. This process fosters personal and spiritual growth, enabling individuals to transcend their limitations and achieve higher consciousness. Transformative learning becomes a pathway for intellectual development and achieving a liberated and enlightened state of being while integrating these principles.

However, Mezirow's (1981) establishment of transformative learning theory research as transformative learning has been widely used in practice. Mezirow (1981) describes transformative learning for the research as "the emancipatory process of becoming critically aware of how and why the structure of psycho-cultural assumptions has come to constrain the way we see ourselves and our relationships, reconstituting this structure to permit a more inclusive and discriminating integration of experience and acting upon these new understandings" (pp. 6-7) as aligned to Mokshā, or liberation. Likewise, the researchers' meaning-making process in their research is unique and changeable, and they include ethical considerations, self-awareness, synthesis of information, tolerance, and the pursuit of deeper meaning. The research itself is a learning process of constructing and appropriating new and revised interpretations of the meaning. This happens for various reasons—truths, values, feelings, needs, desires, critical worldview, and frames of reference (Taylor, 2017). The frame of reference is the performance of the researchers with their reflections on their experiences. Research as transformative learning as/for Mokshā, or liberation, knocks on the door for new epistemological spaces for educators to examine the cultural situatedness of the practices and resonate with the emerging theories of experiential learning, dialogical learning, and inquiry learning (Taylor, 2013). The inquiry's central question in the research process is, how can researchers engage in transformative learning? Transformative research involves a process of critically examining their own (and others') personal and professional values and beliefs, which shape a particular interpretation (Mezirow, 2000; Taylor et al., 2012). In examining critically, reflection gives rise to understanding and developing the meaning. It involves critiquing the deep-seated assumptions and/or problem-solving, which emphasizes understanding more and learning better (Mezirow, 1991) for Mokshā, or liberation, while developing a vision of STEAM-based mathematics education.

Research as transformative learning as/for Mokshā, or liberation, can also be a part of the socio-cultural approach, highlighting personal empowerment and social transformations (Freire, 1970). Equally, as agents of social change, researchers need to be aware of the social and political practices in which they are involved. Eventually, this process enables researchers' "awakening" experiences to engage in an authentic dialectical process and gradually move on to identifying broader meaning (Freire, 1970). The view of knowledge and/or research as practical knowledge (Habermas, 1972) helps to understand and critically analyze knowledge claims within the extrarational approaches. Research as transformative learning based on Habermas's theory (Habermas, 1972) forms the foundation of knowledge and focuses on ways of understanding the types of knowledge. The underpinning of the research as transformative learning brings into account the light of integrated meanings on "the what", "the why", "the how", "the who," and "what next" of research approach in mathematics education and/or STEAM-based mathematics education by creating a space to think of the upcoming direction of transformative research practices (Luitel & Wagley, 2017). Next, in my Swa-Twam-Tat inquiry, I draw upon the view of Ollenburg's (2019) approach, which integrates participatory futures research for change-driven research. By applying design processes and methods within my research, I position participatory future studies as a foundational element in my inquiry. This approach involves examining my (Swa) perspective and engaging with four research participants, a critical friend (Twam), and readers (Tat). Together, I aim to enhance interactions among key actors and inform anticipatory policy (Faucheux & Hue, 2001; Ollenburg, 2019).

In addition, while developing the vision of STEAM-based mathematics education, these processes encouraged and enabled me, my research participants, a critical friend, and readers to account for lived experiences largely in the design space of Gyāna Pranāli. The justification behind this is capturing the key moments of their educational lifeworld through multiple forms as a Vāda of expression, such as stories and dialogues (to name a few). This dimension of the research process enabled me to construct the vision of a life-affirming and meaningful mathematics education as an empowering device (Luitel, 2012). No doubt, research as transformative learning takes into consideration the lived experiences of the researchers—me (Swa), my research participants, and critical friend (Twam) and readers (Tat) to reflect their values, beliefs, thoughts, and practices concerning transformative learning. Likewise, these processes were aligned to the questions: how do researchers change themselves and others? And how do such changes make visible impacts within and outside the researchers' personal and professional lives? In this line, change can be conceived via heightened consciousness, entailing a multi-pronged, multi-dimensional (McLaren & Kincheloe, 2007) and Gyāna Pranāli process for praxis-driven orientation while envisioning transformative STEAM-based mathematics education.

Education for Innovation

In the process of producing knowledge, an active learning environment is required. The active learning environment offers a realistic and/or real-world situation (National Research Council, 2000). These realistic situations provide the conditions for innovation to take place. Likewise, it encourages the learners to try and error, which is essential to innovation. In my inquiry, education for innovation nurtures me with the ability to turn knowledge into action (Cheng & Lin, 2020) with a transformative mindset, promoting a culture of continuous improvement and lifelong learning. This process ensures that I am adaptable and open to new ideas (**See Chapters IV, V, and VI**). These processes develop the confidence needed to set goals and overcome obstacles. However, education for innovation challenges the focus of conventional education from accumulating knowledge to its application and management, which requires constant collaboration with all stakeholders, including educators, students, policymakers, and industry partners. This collaborative approach needs a dynamic learning environment where knowledge is continuously created, shared, and applied to solve real-world problems with a critical reflection as an embedded process.

Next, creativity and innovation in education foster an environment where both learning and teaching become dynamic and inventive processes. This approach shapes the culture for creativity across various dimensions, including curricula design, development of learners' skills, teaching and learning styles, integration of technology, community relations within schools, and assessment methods (Ferrari et al., 2009). So, the multifaceted nature of innovation in education emphasizes the importance of creating and producing knowledge and active learning environments (Freeman et al., 2014; Mohd & Shahbodin, 2015). The innovation process involves trial and error, fostering a transformative mindset that encourages goal-setting and problem-solving. Indeed, the shift from traditional knowledge accumulation to dynamic knowledge management requires constant stakeholder collaboration.

Community Orientation for Educational Processes

Recently, community orientation and involvement in the educational process have been the priority of any educational context for better exposure to the learners (London & Sanchez, 2020) by engaging the learners, teachers, and administrations of the school in a meaningful manner within the school education (Claramita et al., 2019). Likewise, community orientation in educational processes offers learners various opportunities for contextual learning, group learning via activities, leadership skills, and teamwork. These opportunities encourage the learners to be sensitive and responsible for their future and acknowledge the value of education.

In my inquiry (**See Chapters IV-VII**), community orientation facilitates learners to learn and collaborate with teachers, school leadership, and the community to meet local and global needs (Cutchin et al., 2017). In this process, teachers facilitate learning by incorporating recent learning strategies. Leadership plays a vital role in nurturing the overall educational processes with the support of the community as integrated school leadership (Tan, 2024; Tsakeni & Jita, 2019). (Bertrand & Namukasa, 2023). For instance, to address climate change effectively, we must critically evaluate current energy policies, creatively innovate sustainable technologies, and scientifically evaluate their impacts on the environment. In this way, I aim to incorporate this theme to explore meaningful learning experiences for learners and teachers that benefit community engagement in learning processes.

Leadership Within and Without the Context: Reflective Teacher Leader

Leadership in mathematics education also involves establishing and upholding reflective teaching principles while advocating for the significance of mathematics in our contemporary world and beyond. These experiences lead the learners to meaningful mathematical understanding by improving the quality of teaching and learning in a school. Likewise, leadership in mathematics education has two important roles: (1) leadership in defining and maintaining important principles in teaching mathematics and (2) collaborating with the public on making mathematics education meaningful (Posamentier, 2013).

Lambert and Harris (2003) state that teacher leadership does not necessarily have to take the form of a formal position; rather, it is a form of activist agency where teachers are empowered to lead development work that impacts the quality of teaching and learning. In this line, “effective leaders create cultures of high expectations, clarify what teachers are to teach, and students are to learn by establishing strong professional communities and lead ongoing efforts to improve teaching practices in mathematics” (Muir, 2018, pp. 297-298). Inherently, these processes will improve and expand pedagogical skills in mathematics by offering mathematics educators as instructional leaders.

In my inquiry (**See Chapter VII**), drawing from the reflective teacher leader of mathematics, I have discussed my different roles and responsibilities at different times and situations based on my research participants and a critical friend viewpoint. As expressed in the poetic form in the adjoining box, leadership in mathematics education is conceived to nurture me and my research participants to envision and improve the instructional process of STEAM-based mathematics education as reflective teacher leaders across schools based on equity, teaching, learning, and assessment (NCTM, 2000) from an authoritarian leader to reflective leader. Thus, my guiding principles are equity leadership, teaching and learning leadership, curriculum, and assessment leadership as reflective teacher leaders.

> Leading from inside, I question and grow,
> Outside, I listen, shift, and show,
> In both, embrace professional growth.

Glocal Thinking about Mathematics

My understanding of a glocal perspective involves blending global and local viewpoints. It means looking beyond borders to see the world as interconnected while appreciating local communities' unique, context-specific aspects. This approach highlights how global processes influence local realities and vice versa, creating a rich tapestry of diversity and interconnectedness, taking care of local values and indigenous practices. With the above viewpoints, mathematics education and mathematics educators worldwide are directly experiencing an interplay between global and local perspectives (Atweh et al., 2001), such as ethnomathematics, which integrates cultural practices and local knowledge into teaching mathematics, fostering a more inclusive and relevant educational experience that shapes our understanding of the world. With this interplay, mathematics communities exchange their practices (i.e., teaching, learning, designing curriculum, assessment strategies, the process of nurturing the students, integrating technologies—AI and/or GenAI, incorporating innovation, and collaboration with the community, to name a few). The above-mentioned practices shape mathematics education within a global society where our students will live. In this line, being in the local setting to meet students' needs, understand and control their immediate life, and be prepared to survive globally is very important in the present context (Luitel & Taylor, 2007). Nepali mathematics education is also not free from these influences and/or perspectives in the form of globalization as universalization. In comparing the concepts of the 'Global Village' and the diverse 'Global Town,' I must distinguish these perspectives within mainstream mathematics education and STEAM-based mathematics education.

In contrast, Luitel and Taylor (2010) envision the concept of globalization as a space for conversation, a space for incorporating sometimes opposing views, perspectives, and notions related to mathematics education. Likewise, with the help of these spaces, mathematics education programs in Nepal are likely to: "(i) promote both local and global knowledge systems in their curriculum, (ii) dismiss the myth of the superiority of one type of knowledge system over another, and (iii) encourage prospective teachers to conceive their pedagogies in holistic and inclusive ways" (Luitel & Taylor, 2010, p. 406). All the above, in my Swa-Twam-Tat inquiry, global and local perspectives shall offer me and my research participants insights for promoting engaged pedagogical approaches while envisioning STEAM-based mathematics education in/for Nepal.

Empowering Curricular Spaces

Following Schubert's curriculum images (**See chapter IV**), the notion of empowering curricular spaces in my Swa-Twam-Tat inquiry is to explore the shift from a conventional and/or competency-based approach to collaborative learning spaces to empower curriculum spaces with transformative minds (Stetsenko, 2017). The empowering curricular spaces in my inquiry offered to explore a culturally relevant, learner-driven, and socially empowering curriculum for basic skills of the learners' experiences and identity formation (Freire, 1970; Luitel, 2018). Likewise, empowering curricular spaces creates spaces for democratic practices by considering the cultural, psychological, and educational factors based on space and place, which directly influence the learners and their ways of being and becoming. Further, it opens spaces for dialogic communication between teachers and learners to explore the learning experiences. This dialogic communication encourages autonomy and critical thinking, as a result, through effective and meaningful strategies to take agency over their lives and enhance their situation (Duckworth, 2011) in their places.

Luitel (2018) explores how to develop a transformative curriculum vision for mathematics education for inclusive and empowering curricular spaces by including opposing perspectives and ideologies. In addition to this, borrowing the concept of Luitel (2018), I engaged in dialectical interactional texturing among perspectives such as pluralism, synergy, and montage. These processes helped me emerge with transformative potentiality for empowering curriculum spaces by offering pluralism, synergy, and montage to make STEAM-based mathematics more meaningful. Empowering curricular spaces through culturally relevant, learner-driven, and socially empowering approaches can transform education. By fostering democratic practices, encouraging dialogic communication, and integrating diverse perspectives, we can create a more inclusive and effective learning environment that empowers students to take control of their educational journeys and develop the skills they need to succeed in the 21st century.

Reviews of Contemporary Research Studies

My inquiry aimed to develop STEAM-based mathematics education within school curricula. To further conceptualize this approach, I reviewed articles by Pant et al. (2020), Quigley et al. (2020), Perignat and Katz-Buonincontro (2019), and Pratiwi and Khotimah (2022).

To explore STEAM pedagogy in teaching mathematics, Pant et al. (2020) explored the incorporation of STEAM pedagogy in mathematics education, emphasizing the need for interdisciplinary, multidisciplinary, and transdisciplinary approaches. They conducted participatory action research in two schools in the Kavre district, implementing various STEAM projects such as inquiry-based projects, stories, poems, and technology-integrated teaching. Their insights highlighted that reflective practices during the process motivated students toward meaningful learning in mathematics. The study also noted that while STEAM-based teaching was explored, it did not fully connect STEAM concepts to engaged pedagogical processes.

Multiple viewpoints explore STEAM-based mathematics education, emphasizing interdisciplinary approaches, connected learning, and creative problem-solving. These perspectives aim to enhance pedagogical practices and promote meaningful student engagement in mathematics.

Box 5: Multiple Viewpoints of STEAM Education

Similarly, Quigley et al. (2020) addressed the critical need for creative transdisciplinary teaching through STEAM education. They employed connected learning theory to examine STEAM instructional practices via observations, video recordings, and debriefing sessions with teachers. It has helped me further conceptualize the power of connected learning in STEAM-based mathematics education, promoting inclusive and interest-driven learning opportunities for all students. Perignat and Katz-Buonincontro (2019) analyzed 44 articles on STEAM education published between 2007 and 2018, focusing on its definitions, objectives, and the significance of the ‘A’ (Arts) component in STEAM. They found diverse definitions and learning outcomes related to creativity, problem-solving, and art education. Their review underscored the growing interest in STEAM as a pedagogical approach for enhancing students’ creativity and problem-solving skills. Pratiwi and Khotimah (2022) investigated the implementation of STEAM in mathematics education at a junior high school in Surakarta, Indonesia, during the COVID-19 pandemic. Their qualitative study focused on how STEAM fosters critical and creative thinking through project-based learning. Collectively, the works of Pant et al. (2020), Quigley et al. (2020), Perignat and Katz-Buonincontro (2019), and Pratiwi and Khotimah (2022) emphasize interdisciplinary approaches and connected learning in mathematics. They highlight the importance of creativity, problem-solving, and technology integration, underscoring the need for engaged, inclusive pedagogical practices to enhance meaningful learning.

However, the article "Exploring Teachers' Understanding and Implementation of STEAM: One Size Does Not Fit All" by Boice et al. (2024) examines how K–12 educators perceive and apply STEAM education within a professional learning program. Conducted over 4 years, the study involved 61 teachers participating in the GoSTEAM@Tech initiative at Georgia Tech, utilizing a mixed-methods approach to evaluate changes in their understanding and teaching practices. The insights indicate that many teachers initially had superficial or fragmented views of STEAM, often seeing it as an "add-on" rather than an integrated teaching method. Likewise, exploring the arts in traditional STEM (science, technology, engineering, and mathematics) education, Videla et al. (2021) argue that the shift from STEM to STEAM fosters a more holistic and interconnected learning experience grounded in enactive and ecological educational theories highlighting the benefits of interdisciplinary approaches, emphasizing that incorporating the arts enhances creativity, student engagement, and real-world problem-solving skills.

Reflecting on the reviewed literature, a significant research gap exists in bridging the conceptual promise of STEAM-based mathematics education with its practical, systemic implementation, particularly concerning curriculum spaces, engaged pedagogies, professional development, and leadership. While foundational studies (Pant et al., 2020; Perignat & Katz-Buonincontro, 2019; Pratiwi & Khotimah, 2022; Quigley et al., 2020) advocate interdisciplinary approaches, connected learning, creativity, and problem-solving, they primarily demonstrate potential or isolated successes without fully addressing the structural and procedural challenges of integration. Crucially, they offer limited guidance on redesigning formal curriculum spaces to accommodate truly transdisciplinary STEAM mathematics beyond project-based add-ons systematically, nor do they deeply explore the specific mechanisms of engaged pedagogies that authentically weave the "A" into mathematics for meaningful learning beyond motivation. Furthermore, the persistent finding by Boice et al. (2024) that teachers often hold superficial, fragmented views of STEAM as an "add-on" underlines a critical gap in effective, sustained professional development models capable of shifting teacher understanding and practice towards integrated implementation. Literature also largely neglects the essential role of reflective leadership as a reflective leader in creating supportive school cultures, allocating resources, providing ongoing coaching, and developing policies that enable and sustain the complex shift towards STEAM mathematics across curriculum, pedagogy, and teacher growth. Videla et al.'s (2021) theoretical grounding highlights the *why* of integration but does not resolve *how* to overcome these systemic implementation barriers identified by Boice et al. Therefore, the gap lies in envisioning STEAM-based mathematics education that simultaneously redesigns curriculum structures, defines and supports authentic STEAM-engaged mathematics pedagogies, implements transformative professional development, and establishes enabling leadership practices as reflective leaders for scalable and sustainable integration.

Research Trends in STEAM Education

My inquiry explored how the development of social, cultural, and economic sectors is intrinsically linked to providing quality education. Education serves as a conduit for developing knowledge, skills, values, and worldviews, enabling learners to engage in sustainable living practices (Huang et al., 2024; Pant et al., 2023). STEAM education, an emergent pedagogical approach, facilitates the acquisition of knowledge and skills, including the 4Cs of 21st-century skills—critical thinking, creativity, collaboration, and communication—thereby fostering sustainability education (Dahal, 2022b; Quigley et al., 2017). STEAM education extends beyond the traditional STEM framework by incorporating the Arts, not merely as an amalgamation of five or more distinct disciplines but as an integrated educational approach. This approach promotes inquiry-based learning (Science), technological proficiency (Technology), design thinking (Engineering), creativity and imagination (Arts), and everyday problem-solving (Mathematics). Consequently, STEAM education explores contemporary trends in educational research, encompassing inquiry-based, project-based, integrated, design-based, and arts-based learning, as well as pedagogical trends, curriculum development models, techno-educational trends, transformative trends, and methodological trends. This holistic approach equips students with scientific, technological, engineering, arts, and mathematical competencies to successfully navigate real-world scenarios and future workplaces.

Pedagogical trends in STEAM education are predicated on the understanding that learners engage with content through diverse approaches and learning styles within varied environments, utilizing a range of linguistic and non-linguistic materials (Bertrand & Namukasa, 2023). Scholars in this field investigate various pedagogical models to cultivate creative and critical thinking and problem-solving skills essential for addressing glocal crises. Research on curriculum praxis in STEAM education examines different approaches to curriculum integration, such as problem-based learning, STEAM maker lessons, and inquiry-based teaching practices (Mengmeng et al., 2010; Quigley et al., 2020). These models provide insights into creating cohesive curriculum structures that meaningfully integrate STEAM disciplines (Al-Mutawah et al., 2022; Jia et al., 2021), thereby challenging and transforming existing educational paradigms. Transformative orientation in STEAM education investigates various learning modalities—passive versus active, personalized versus collaborative, and conventional versus progressive (Taylor & Taylor, 2019). These dialectics encourage students to integrate science, technology, engineering, arts, and mathematics knowledge to address real-world problems and foster creativity, critical thinking, and problem-solving skills. Transformative methodological trends, including autoethnographic, action research, participatory research, participatory action research, and collaborative research, are pivotal in enabling scholars to understand the role of empowering and collaborative research in STEAM education (Prahani et al., 2023). These trends facilitate the transition from individual inquiry to community-based knowledge generation. Figure 2 illustrates my conceptualization of STEAM-based mathematics education.

Figure 2

My Conceptualization of STEAM-based Mathematics Education

STEAM-Based Mathematics Education in My Inquiry

There have been several initiatives in STEAM in educational institutions in Nepal by local-level governments, provincial governments, federal governments, NGOs, and INGOs. So, the education system in Nepal is also seeking a possible shift by implementing integrated teaching and learning approaches to education. Furthermore, by 2019, the Department of STEAM Education at Kathmandu University School of Education had initiated developing, exploring, and implementing innovative and integrated STEAM pedagogy. This approach blends multidisciplinary and transdisciplinary designs and has led to the launch of various higher education programs: MPhil in 2019, Ph.D. in 2020, One-Year MEd in 2020, One-Year PGDE in 2023 (now emerged as PGDE in STEAM Leadership), and Two-Year MEd in STEAM in 2024.

In STEAM-based mathematics education, math concepts become concrete objects for problem-solving to create meaningful learning experiences.

As a STEAM scholar, as expressed in the adjoining box, I realized that incorporating STEAM in mathematics education for students has shown promising outcomes by enhancing both learning engagement and understanding. Koirala and Neupane (2023) investigated STEAM-based integrated programs in Nepali schools, noting significant improvements in problem-solving skills and creativity. This integration facilitates real-world application, making math more accessible and enjoyable (Kim & Park, 2012). Furthermore, studies like that of Kim and Park (2012) in South Korea illustrate that adding arts to traditional STEM areas increases students' motivation and collaborative skills. The creative elements within STEAM encourage students to express mathematical concepts visually and abstractly, enriching their learning experience (Nutov, 2021). In Nepal, Belbase et al. (2022) highlighted that STEAM education helps bridge the gap for underrepresented groups, even in mathematics, promoting a more inclusive environment. The diversity of approaches within STEAM can cater to a wide range of learning styles and cultural backgrounds, offering various entry points to understanding complex mathematical ideas (Alsina Pastells & Silva Hormazábal, 2023).

Despite the considerations above, the shift toward a STEAM-based approach in mathematics education explores its usefulness in promoting a comprehensive understanding and a deeper appreciation of mathematical concepts and ideas among learners across various contexts, pedagogies, and school settings through an integrated approach that blends multidisciplinary and transdisciplinary design (Hou, 2024; Kim & Wilkinson, 2019; Kim et al., 2019). By incorporating contextual applications and fostering critical thinking, creativity, and collaboration, researchers and/or educators can make mathematics more relevant and engaging. Additionally, it is essential to consider the potential challenges, such as the risk of diluting mathematical rigor or the difficulty in assessing interdisciplinary learning outcomes. Meaningful teaching-learning requires internal and external connections (NCTM, 2016). Multidisciplinary to transdisciplinary approaches are regarded as educational tools that can accommodate various educational changes by integrating two or more subjects. These approaches create the “creativity-fusion” capabilities in mathematics education and connect them to real-world contexts (MOE, 2016).

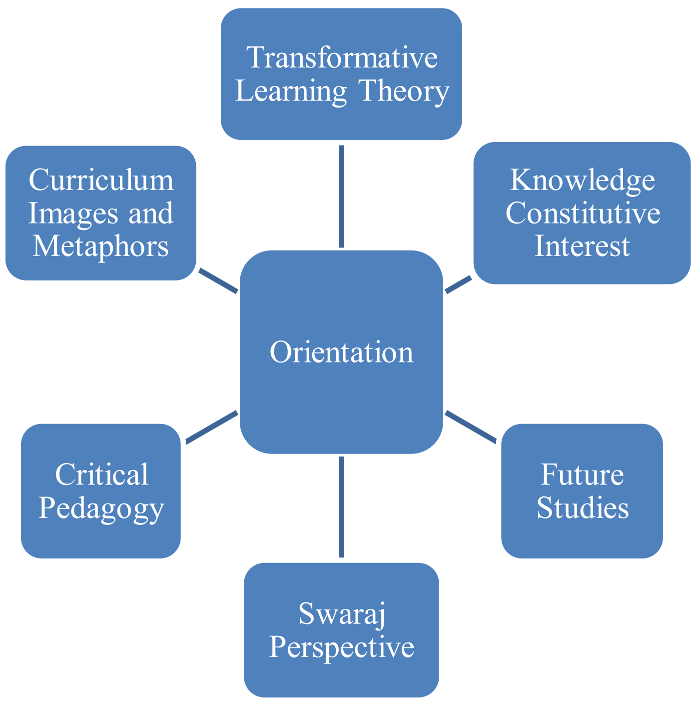
Drawing from the above, in conceptualizing and envisioning STEAM-based mathematics education, the study of Richard and Biffle (2016) allows me to illustrate the relationship between curriculum, pedagogy, lifelong holistic learning habits, PD for change, and reflective leadership. Further, STEAM education extended my ability to use problem-solving, fearlessness, collaboration, critical thinking, designing challenges, and tactile skills that each learner needs (Maeda, 2013). Likewise, moving forward with STEAM curricula encourages students to be engaged, empowered, and to think about their education’s real-world applications (Jackson, 2015). In this line, STEAM educators are being challenged to design curricula and pedagogies in integrated ways to develop students’ abilities as critical consumers, creative and ethically wise citizens, innovative designers, good communicators, and collaborative decision-makers (Taylor, 2015). Inherently, this orientation gives rise to content and pedagogical methods of school mathematics that need to be updated as per the country's needs and learners' needs for meaningful teaching-learning (Kim & Wilkinson, 2019; Kim et al., 2019). Meaningful teaching-learning requires internal and external connections (NCTM, 2016). These connections offer a mathematics education (teaching-learning mathematics) view from multidisciplinary to transdisciplinary approaches.

In addition to the above, *education for innovation* (Cheng & Lin, 2020; Ferrari et al., 2009; National Research Council, 2000), *community orientation for educational processes* (London & Sanchez, 2020; Claramita et al., 2019; Cutchin et al., 2017), *leadership in mathematics education* (Posamentier, 2013; Lambert & Harris, 2003;

NCTM, 2000), *global and local perspectives* (Atweh et al., 2001; Luitel & Taylor, 2007; Luitel & Taylor, 2010), *empowering curricular spaces* (Freire, 1970; Luitel, 2018; Duckworth, 2011; Luitel, 2019) and *empirical reviews* of Pant et al. (2020), Quigley et al. (2020), Perignat and Katz-Buonincontro (2019) and Pratiwi and Khotimah (2022) studies support me to be familiar and further conceptualize STEAM-based mathematics education. Finally, STEAM-based mathematics, in my inquiry, envisions STEAM-based mathematics education for fostering citizenship education within relation ontologies of the individual self, relational selves, and universal self. Given these perspectives on STEAM-based mathematics education (See Chapter I), I have drawn the following map in Figure 3 to show the theoretical and perspective orientation of my inquiry.

Figure 3

Theoretical and Perspective Orientation



Chapter Summary

This chapter has deepened my understanding of transformative STEAM education and STEAM-based mathematics education. Within this chapter, I reviewed and conceptualized STEAM-based mathematics education in the areas: (1) STEAM education: philosophical perspectives; (2) fallible and absolute nature of STEAM education; (3) economic rationalism to STEAM education; (4) Contextualism and universalism in STEAM education; (5) integrated learning:

multi/inter/transdisciplinary approaches; (6) transformative STEAM education as/for Mokshā (Liberation); (7) education for innovation; (8) leadership within and without the context: reflective teacher leader; (9) glocal thinking about mathematics; (10) empowering curricular spaces; (11) reviews of contemporary research studies; and (12) research trends in STEAM education. Towards the end of this chapter, I discussed my theoretical referents (lenses) and presented the theoretical and conceptual framework for my inquiry, along with the chapter summary. In the next chapter, Chapter III, I have shared the roadmap of my inquiry.

CHAPTER III
ROADMAP OF MY SWA-TWAM-TAT INQUIRY

This chapter outlined the roadmap of my Swa-Twam-Tat inquiry, which explores the individual self, relational selves, and universal self within the Gyāna Pranāli design space. So, my inquiry is a broad process that involves different paths or procedures. In contrast, formal research aims to establish facts and/or findings. Therefore, my inquiry emphasizes asking questions as an inquirer (Denzin, 2016). Although I have used the terms "inquiry" and "research" interchangeably, my focus is primarily on asking questions as an inquirer to envision transformative STEAM-based mathematics education. It encompasses Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda. The chapter critically examines my research methodology, thoroughly interrogating the inquiry process and guiding future research. So, the chapter included discussions on philosophical assumptions, the Gyāna Pranāli design space, Swa-Twam-Tat inquiry as a research methodology, inquiry spaces, Ākhyāna writing as the process of inquiry, ensuring the quality of my inquiry, ethical considerations, and chapter summary.

Philosophical Assumptions of My Research

Swa-Twam-Tat inquiry is proposed to be a philosophical approach rooted in the Eastern concept of 'Tat Twam Asi' (meaning *you* are *that*), which emphasizes the non/dual unity of the individual, dialogical, and universal self. This approach features the interconnectedness of all existence and promotes relational ontologies, challenging the dominance of somewhat dualistic epistemologies by fostering a more inclusive and culturally sensitive understanding of knowing (Dahal et al., 2024a). Here, the Swa-Twam-Tat inquiry is a system of beliefs and assumptions that contribute to new knowledge development and guide the inquiry process through first, second, and third person inquiries (Saunders, 2015). Swa inquiry is the first-person inquiry based on self-reflection through journaling, meditation, introspection, and autoethnography. Twam inquiry focuses on second-person participant engagement, including interviews and collaborative inquiry. Tat inquiry entails a third-person exploration of broader contexts using ethnography, field research, comparative studies, and document analysis. In developing my vision of STEAM-based mathematics education, my worldviews comprise my beliefs and philosophical assumptions about the nature of the world and how it can orient me to conduct this inquiry. It is the lens through which I, as a researcher, view the world and examine the methodological components of my inquiry to decide on the methods for field text, narratives, voices, and reflective notes collection and analysis. So, the context of my inquiry is not free from social, cultural, political, and environmental settings aligned with Eastern philosophical assumptions such as Dharma (moral and ethical duty that guides an individual's actions and responsibilities), Karma (principle of cause and effect, and actions determine one's future experiences), Gyāna[2] (signifies knowledge and wisdom, particularly spiritual and philosophical understanding), and Prajñā[3] (focuses on insight and discernment, associated with enlightenment and deep comprehension). Further, as a result, human beliefs, values, thoughts, and actions require consciously aware types of assumptions. These assumptions in my inquiry, namely axiological, ontological, and epistemological, shape the overall process of the inquiry—epistemological positions, methodological approaches, and meaning-making process (Cohen et al., 2011). Slash (/) has been used as a dialectical association for synthesizing otherwise opposing philosophical assumptions. The philosophical assumption of my inquiry contains axiological, ontological, and epistemological assumptions and/or nuances that deal with the types of knowledge and embedded values (ways of my values influence my research process), nature of reality (realities I encounter in my inquiry), and ways of knowing (human knowledge).

Axiological Assumptions

Governed by the question — how can I respectfully conduct the inquiry? While exploring my values, beliefs, and influential roles as a self-narrator while reflecting on my *Dharma* and *Karma* (Bhangaokar & Kapadia, 2009; Dahal & Luitel, 2022) in my inquiry by blending personal narratives with ethnographic insights, acknowledging subjectivity and context. So, this inquiry is guided by Dharma (righteousness) and Moksha (liberation) principles. It emphasizes the ethical and spiritual dimensions of inquiry, aiming to contribute to the holistic well-being of individuals and society (Swami Vivekananda, 1896). This approach facilitates a comprehensive understanding by bridging the gap between so-called analytical rigor

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[2] www.wisdomlib.org. (2024d, October 24). Gyana, Gyan, Gyāna: 4 definitions. https://www.wisdomlib.org/definition/gyana

[3] Wikipedia contributors. (2024a, August 19). Prajñā (Buddhism). Wikipedia. https://en.wikipedia.org/wiki/Praj%C3%B1%C4%81_(Buddhism)

and the ethics of doing good to self and other perspectives in my inquiry to govern my axiological position.

Likewise, my inquiry is value-laden. Thus, the inquiry site, research context, researcher (e.g., myself), participants, a critical friend, and readers' perspectives impact my research process masterly aligned with relational ethics, spiritual and ethical values, co-constructed narrative, intuition and insight, interactive dialogues, and narrative ethnographies. Likewise, I have valued the opposing perspectives of my research participants and a critical friend while addressing the readers throughout the research process—before, during, and in the exploration or generation of field text, narratives, voices, and reflective notes. Multiple and/or relative realities emerge while envisioning STEAM-based mathematics education during this process. However, my insights and/or research process have not been sufficient to understand the entire inquiry process; in particular, it might be helpful to understand my perspectives or values, integrating my ethical, spiritual, and holistic perspectives.

Ontological Assumptions

Considering Tātva (the essence of reality and existence), Nāma (the conceptual labeling or naming of entities), and Rūpa (entities' physical form or appearance), my ontological assumptions and stances are to envisage STEAM-based mathematics education. Tātva represents the essence or reality that underpins all phenomena, which is crucial for understanding the nature of my inquiry, another aspect of truth. Nāma signifies the conceptual labeling or naming of entities, reflecting the human tendency to categorize and define reality. Sat occurs in a Rūpa, which denotes entities' physical form or appearance, emphasizing the tangible aspects of reality that are observed and analyzed in inquiry. So, the ontological assumption of my inquiry is rooted in non-dualism, which posits that the universal reality and the individual self are one and the same (Shankaracharya, 8th century). This perspective sees limitations in the duality between the observer and the observed, emphasizing the unity of existence.

Thus, my ontological assumptions and/or stances are concerned with the study of being in a field with a rich cultural context (Willis, 2007) as a response to the question—what is there that can be known? Or what the nature of the realities I have encountered or explored is, emphasizing interconnectedness, dynamic reality, and the importance of inner experiences. Interconnectedness in Eastern philosophy means all elements of the universe are seen as deeply interconnected, influencing and shaping each other in a complex web of relationships. Non-dualism posits that the apparent separation between the self and the universe is an illusion, advocating for a unified, singular reality. Next, reality is perceived as a continuous, dynamic flow, constantly evolving and transforming rather than remaining static. Also, inner experiences and subjective insights are valued as crucial sources of knowledge, offering thoughtful understanding beyond empirical observation. Likewise, during the research process to envisage STEAM-based mathematics education, different discourses, values, and perspectives have emerged, aligned to interconnectedness, non-dualism, and dynamic reality connecting to inner experiences, giving rise to multiple realities.

In contrast, I also believe that reality is inseparable from the research context guided by the questions: what is true in the social world? How do I know what I know? And how do I understand or conceptualize cultural context? With these contexts in mind, I have acknowledged the existence of multiple realities opposing unique, subjective, objective, local, and universal realities generated during my inquiry process that are aligned to interconnectedness, non/dualism, and dynamic reality, connecting inner experiences in different stages of engagement.

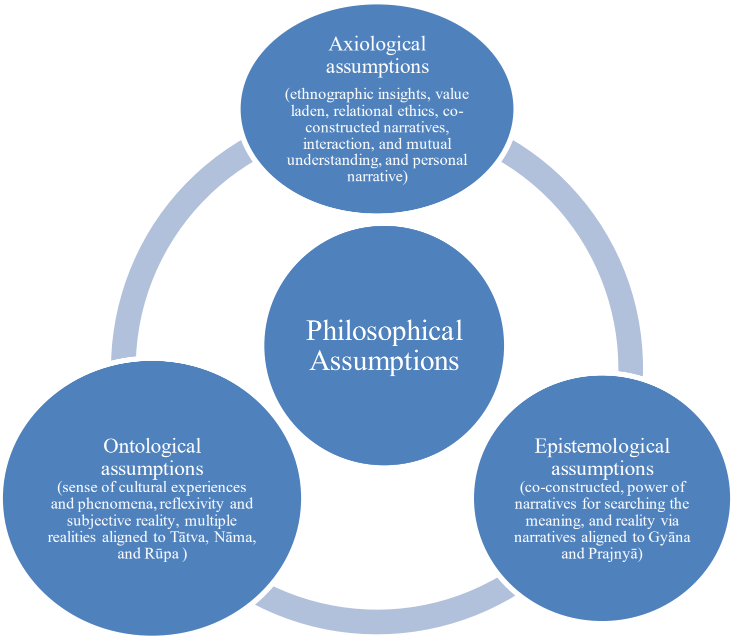
Epistemological Assumptions

My epistemological assumptions are rooted in Gyāna and Prāgyan for my inquiry to envisage STEAM-based mathematics education. Gyāna (knowledge and knowing) encompasses knowledge generation, emphasizing the subjective and constructed nature of understanding in my inquiry. Prāgyan (wisdom) highlights the application of deep, contextual wisdom, reflecting the integration of experiential insights and critical reflection in post-epistemological studies. Thus, my epistemological approach is drawn from subjective and objective traditions. Knowledge is acquired through introspection, meditation, and the guidance of the Upanishads and the Bhagavad Gita (Radhakrishnan, 1953). This approach values subjective experience, inner realization, and empirical observation.

So, my epistemological assumptions are drawn from philosophical and spiritual traditions of knowledge and knowing by valuing holistic, intuitive, and experiential knowing (Crotty, 2003; Taylor, 2014). Likewise, my epistemological assumption is that knowing is subjective and is derived from the interconnectedness of all things; no objective 'reality' nor 'truth' is out there residing somewhere to be discovered; rather, realities are constructed by social actors through social interaction, connecting intuitive and experiential knowledge. Thus, knowing is co-constructed by myself, my participants, and a critical friend, inviting the readers, and it emerges from the inquiry process (Shrestha, 2018) by promoting a deeper and more integrated understanding of reality. Next, how do I explore knowing, and what limits were also considered in my epistemological considerations? While exploring multiple realities as different ways of knowing, I have used narrative and experiences, focusing on understanding lived experiences by incorporating views, perspectives, and values throughout my meaning-making process. I have attempted to illustrate the philosophical assumptions of my inquiry in Figure 4 below.

Figure 4

My Philosophical Assumptions



Gyāna[4] Pranāli[5] Design Space

Gyāna Pranāli is a proposed system that integrates Eastern philosophical systems with my contemplative practices. It proposed emphasizing the synthesis of subjective and objective knowledge, aligning with principles of unity and interconnectedness of duality (Prasad, 2002). This system is particularly suited for exploring my inquiry, as it bridges the gap between spiritual knowing and academic pursuits. Thus, Gyāna Pranāli is an approach that integrates different Gyāna (i.e.,

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[4] www.wisdomlib.org. (2024, October 24). Gyana, Gyan, Gyāna: 4 definitions. https://www.wisdomlib.org/definition/gyana

[5] www.wisdomlib.org. (2024a, August 15). Pranali, Prāṇalī, Prānalī: 10 definitions. https://www.wisdomlib.org/definition/pranali

knowledge and knowing) within a design space to explore and think beyond disciplinary boundaries, fostering transformative approaches to STEAM education. “Gyāna” derived from Sanskrit, translates to knowledge and wisdom, often encompassing a deep understanding of both theoretical (i.e., abstract and objective) and practical (intersubjective, context-specific) aspects of a subject. “Pranāli” means system, methodology, or beliefs, referring to the structured approach or framework used to acquire and apply knowledge. The design space represents the range of possible configurations that can be explored to address an inquiry. Integrating “Gyāna” ensures that the knowledge base is comprehensive, while “Pranāli” provides an organized approach to navigating the design space, ensuring that the exploration is methodical inquiry. This synergy of subjectivity and objectivity offered me an essential for knowing and developing practical, impactful solutions while envisioning STEAM-based mathematics education. So, this inquiry aims to envision STEAM-based mathematics education and critically assess my own lived experiences by integrating felt and seen, subjective and universal, and local and global. Different perspectives of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda further embraced my ways of exploring, interpreting, and meaning-making.

Bahuprasnavāda[6]

Bahuprasnavāda is a proposed paradigm rooted in the Eastern philosophical tradition, particularly in the Nyaya and Vaisheshika schools of thought. Nyaya aligns with logic and epistemology for acquiring knowledge through perception, inference, comparison, and testimony, and is known for its systematic approach to reasoning and debate. Vaisheshika is concerned with metaphysics and ontology, exploring the nature of reality by categorizing substances, qualities, and actions. It posits that understanding the universe and these fundamental elements leads to knowledge of the world. The term "Bahuprasnavāda" can be broken down into Bāhu (many) and Prasna (questions), signifying a method of inquiry that involves asking many questions to explore a topic comprehensively. This paradigm emphasizes critical thinking, logical reasoning, and systematic questioning to better understand truth. Thus, [7]I employed

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[6] Wikipedia contributors. (2024, September 12). Prashna Upanishad. Wikipedia. https://en.wikipedia.org/wiki/Prashna_Upanishad?fbclid=IwY2xjawGS3NdleHRuA2FlbQIxMAABHW-bSVxku_BXEI3KcZDG_VKDJ9Qy1ZsrdFT38lR6lPa1OP31tPtl24OXCQ_aem_DykrV-mZKv4Dv6E9UsJdMA

[7] Disclaimer: Some section of pp. 52-53, has been published in Autoethnography: Writing lives and telling stories. *Journal of Transformative Praxis, 2*(1), 1-7. https://doi.org/10.51474/jrtp.v2i1.530

Bahuprasnavāda to examine existing mathematics pedagogies and envision STEAM-based mathematics education through the help of multifaceted questions. In so doing, I have critically reflected on 'Swa', 'Twam and Tat' for identifying questions and transforming socially from unjust structures, beliefs, and practices termed as *deep democracy* (Kincheloe & Mclaren, 2000) in my field where I am engaged. As a critical researcher, my role in my inquiry context was to incorporate advocacy and/or other forms of active engagement (Taylor et al., 2012) as a change agent. Likewise, the Bahuprasnavāda is the key paradigm that informs me to be critical about 'Twam and Tat' traditions, thoughts, and actions, and gives rise to conscious awareness to be prepared for envisioning new perspectives and practices. Thus, the Bahuprasnavāda helped me (Swa), my participants, a critical friend (Twam), and readers (Tat) to empower myself and others during the inquiry. However, Bahuprasnavāda may struggle to integrate diverse perspectives due to its complexity and the potential for conflicting viewpoints. Due to the limitation of Bahuprasnavāda, I have subscribed to Bahurūpavāda as a supportive Gyāna Pranāli in my inquiry to be more expressive, to be connected with minds and hearts for the representation of Swa-Twam-Tat thoughts and feelings through multiple forms of logics and genres as a Vāda[8].

Bahurūpavāda[9][10]

Bahurūpavāda translates to "the doctrine of manifold forms" or "multiplicity." It emphasizes the diversity and plurality of existence, perspectives, and truths. As a proposed paradigm, Bahurūpavāda offers an approach to understanding and exploring complex phenomena by acknowledging and integrating multiple viewpoints, methodologies, and realities. Thus, I employed Bahurūpavāda as a window for me to connect Twam-Tat as a relational and universal selves and heart through subjective lenses so that I can capture inaccessible and ineffable everyday realities (e.g., beliefs, attitudes, values, emotions), and present them using various modes of logic and genres (Luitel, 2012; Qutoshi, 2015; Luitel, 2019) as Vāda. These modes of logics and genres include dialectical, narrative, metaphorical, poetic, and visual forms, such

[8] www.wisdomlib.org. (2024b, August 23). Vada, Vāda: 31 definitions. https://www.wisdomlib.org/definition/vada

[9] www.wisdomlib.org. (2024, October 24). Bahurupa, Bāhurupa, Bāhurupā, Bahu-rupa: 21 definitions. https://www.wisdomlib.org/definition/bahurupa?fbclid=IwY2xjawGS2RxleHRuA2FlbQIxMAABHWKcqaaLeKIs7_-Af9NlJqG56ZiVamQCh0pjAcxa84p4ZQAmxe0U4ETvlw_aem_mDyk5ALZ61geoZRqErPglg

[10] SB 2.9.2 Srimad-Bhagavatam. (n.d.). PrabhupadaBooks.com. https://prabhupadabooks.com/sb/2/9/2?d=1

as story, play, fiction, and poem (Dahal & Luitel, 2022). Vāda refers to a philosophical discourse or debate aimed at exploring and establishing truths through logical argumentation and reasoning. These Vāda included dialectical, poetic, narrative, and metaphorical. Likewise, the Bahurūpavāda adds pluralism and liveliness to Swa's work, providing a rich repertoire of modes of inquiry. The new forms of representation as a Vāda—literary and visual imagery—have helped in my Swa-Twam-Tat inquiry to explore my (Swa) and others—research participants, a critical friend, and readers (Twam-Tat) lived and living experiences while developing different forms of narratives (e.g., evocative, collaborative, and performative) for envisioning STEAM-based mathematics education. However, I have also offered the Bahuarthavāda as a support to Gyāna Pranāli to reflect upon my actions and reactions while utilizing Ākhyāna writing as the process of inquiry for meaning-making. So, Ākhyāna is portrayed as a method for inquiring into the meaning derived from narratives, such as stories.

Bahuarthavāda[11]

Bahuarthavāda, which can be translated as "the doctrine of multiple meanings" or "pluralism in interpretation," is a philosophical and hermeneutic approach rooted in Eastern intellectual traditions. It emphasizes that texts, concepts, or phenomena can have multiple valid interpretations depending on the inquiry's context, perspective, and purpose as a lens to understand the world. As a paradigm, Bahuarthavāda offers a framework for embracing diversity, plurality, and contextual understanding in academic and intellectual pursuits. Thus, the notion of Bahuarthavāda is governed by human behaviors. The methods of social sciences should probe human behaviors. This indicates that the Bahuarthavāda Gyāna Pranāli in my Swa-Twam-Tat inquiry demands the interaction with myself (Swa as individual self), my research participants, and a critical friend (Twam as relational selves) and readers (Tat as universal self), which helps to reflect upon my (Swa) and participants' actions (Twam) and readers (Tat), thereby interpreting the multiple realities for meaning-making rooted on Gyāna and Prāgyan for my inquiry. Gyāna signifies the pursuit of knowledge and wisdom in spiritual and philosophical contexts. Prāgyan represents

[11] Suresvaracharya. (n.d.). How the non-sentential sense arises from the Sruti text (Vol. 12, pp. 1901–2088). https://vedantastudents.com/wp-content/uploads/2019/03/12-Naishkarmya-Siddhi-Volume-12.pdf?fbclid=IwY2xjawGS3CZleHRuA2FlbQIxMAABHT48HYHqmczCNs0qCjNIdu9ThUU76-URPzEkuTRojN-jeohN-EB7zEAeuA_aem_3mRgYrSMpeIKsm6A1CcKtQ

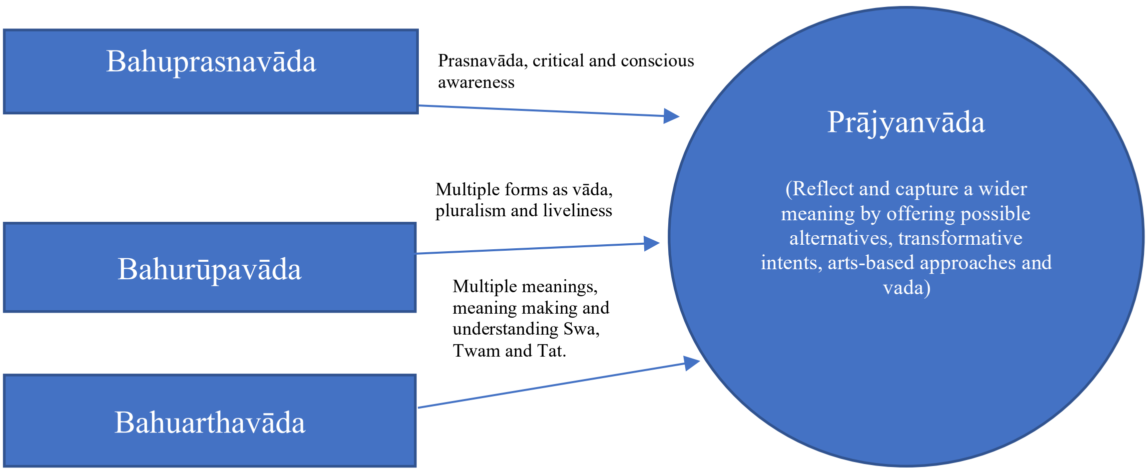
insight and discernment, associated with enlightenment and deep comprehension. In this line, the Bahuarthavāda Gyāna Pranāli in my inquiry helps generate a context-based and/or context-responsive understanding of myself and my research participants' thoughts, beliefs, values, and associated with social actions (Taylor et al., 2012; Qutoshi, 2015). As a result, I got a chance to exercise the Bahuarthavāda Gyāna Pranāli to envision STEAM-based mathematics education. As a Bahuarthavāda researcher, I find in-depth descriptions and interpretations necessary to understand the inquiry spaces, such as the inquiry spaces, context, and participants. Still, they are not limited to myself (Swa). So, I have engaged in a deeper understanding of the phenomenon to envision STEAM-based mathematics education. However, I also subscribed to the Prājyanvāda as a supportive Gyāna Pranāli to enable myself (Swa), research participants, a critical friend (Twam), and readers (Tat) to envision holistically the stories of our professional experiences that are interpreted subjectively.

Prājyanvāda

Prājyanvāda is aligned with philosophical discourse emphasizing the pursuit of wisdom and thoughtful understanding through critical inquiry and reflective dialogue. So, Prājyanvāda, a term rooted in Sanskrit, can be interpreted as a discourse or philosophy centered on abundance, wisdom, and holistic understanding. As a proposed paradigm, it represents an approach emphasizing interconnectedness, pluralism, and the pursuit of knowledge by synthesizing diverse perspectives. It aligns with principles of inclusivity, ethical inquiry, and integrating traditional wisdom with modern scientific methods. Thus, I employed Prājyanvāda Gyāna Pranāli as an enabler for envisioning holistically transformative STEAM-based mathematics education. This holistic view from different perspectives and theories—transformative learning theory (Mezirow, 1991), knowledge constitutes interests (Habermas, 1972), critical pedagogy (Freire, 1970), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019) within the Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda enabled me, my research participants and critical friend and readers to reflect on and captured a wider meaning of educational practices in STEAM-based mathematics education by offering possible alternatives to my inquiry (Taylor et al., 2012; Qutoshi, 2016). Likewise, reflection enabled me to think holistically about alternatives to construct the vision of STEAM-based mathematics education. These alternatives cover the viewpoints of tolerance, dialectical, ability to synthesize, and synergizing. Tolerance covers accepting and respecting diverse perspectives, viewpoints, and beliefs in the inquiry process. Likewise, seeking to resolve contradictions and uncover truths, dialectical offers the method of dialogue and reasoning. The ability to synthesize is the skill of combining different ideas and information to form a coherent and comprehensive understanding. Synergizing means working collaboratively to create a combined effect that is more significant than the sum of individual efforts. While capturing a wider meaning, I used multiple logics and genres as a vāda—imagination and perspectival language while narrating my lived experiences (Taylor, 2015). These writing processes enabled me to use the metaphor of knowing as reconceptualizing self, which opened my views aligned with my research participants and a critical friend (Twam) and readers (Tat), and provided an opportunity to critique my 'self' (Taylor, 2013). In this way, the integral view of my Swa-Twam-Tat inquiry allowed me to employ multiple logics and genres as a Vāda—imagination and perspectival language to crystallize my questions in fostering the envision of STEAM-based mathematics education. Figure 5 shows the design space of my inquiry.

Figure 5

Gyāna Pranāli Design Space of my Swa-Twam-Tat Inquiry



Swa-Twam-Tat [12] Inquiry as Research Methodology

Starting with conceptualizing the Swa-Twam-Tat inquiry, I refer to the individual self (referred to as Swa) as the central focus of self-investigation, deeply

[12] SaaTwik. (2023, August 7). गायत्री मंत्र गुप्त रहस्य, अर्थ एवं चमत्कारी शक्ति | @SAATWik [Video]. YouTube. https://www.youtube.com/watch?v=JNAZii91oFU

rooted in the teachings of Advaita Vedanta. This non-dualistic philosophy seeks to uncover the true nature of the self and its relationship to the universal reality (Tat). The essence of this inquiry is encapsulated in the statement "Tat Tvam Asi" (Thou art That) (Dahal et al., 2024a; SaaTwik, 2023), which points to the fundamental identity between the individual self and the universal Self with a bridge of dialogic other (Twam). The individual self is often mistaken for the ego or the personality, which is tied to the body, mind, and senses. However, in Advaita Vedanta, the true individual self is understood as the innermost essence of a being, transcending the limitations of the physical and mental spheres. Atman is described as eternal (beyond birth and death), conscious (the source of awareness), blissful (free from suffering), and non-dual (not separate from Brahman, the universal Self). Thus, the Swa-Twam-Tat inquiry involves a deep investigation into the nature of the individual self to discern its true identity, a process known as Atma Vichara (self-inquiry), which is a key practice in Advaita Vedanta. This inquiry begins by questioning the identity we commonly associate with ourselves—the body, mind, emotions, and thoughts—recognizing that these are temporary and changing and thus cannot be the true self. Through discrimination, one separates the eternal from the transient, realizing the true self as the unchanging witness of all experiences. The individual self is understood as the silent observer of thoughts, emotions, and actions—not the doer, but the pure awareness behind all activities. Through deeper inquiry, one comes to realize that the individual self is not separate from the universal Self, which is the essence of Tat Tvam Asi. The perception of separation between the individual self and the universal Self arises due to Maya (illusion), which creates the appearance of duality. This illusion is caused by ignorance (Avidya) of one's true nature (Dahal, 2022). The Swa-Twam-Tat inquiry aims to dissolve this illusion and recognize the non-dual reality. Practical steps in this inquiry include meditation and self-reflection, which help quiet the mind and turn attention inward to explore the nature of the self.

The central question, "Who Am I?", is repeatedly asked to peel away layers of false identity and uncover the true self. Studying sacred texts like the Upanishads, Bhagavad Gita, and the works of sages such as Adi Shankara provides guidance on the nature of the self, while the guidance of a qualified Guru helps dispel doubts and leads the seeker toward self-realization. The culmination of the Swa-Twam-Tat inquiry is the realization that the individual self (Swa) is not separate from the universal reality (Tat). This realization is the essence of non-duality (Advaita), where the individual self is understood as a reflection or expression of the universal Self, much like waves are expressions of the ocean. Recognizing the true self as eternal and blissful liberates one from the fear of death and the cycle of suffering. It fosters compassion and unity as the oneness of all beings becomes apparent, and it leads to the transcendence of the ego, which thrives on separation and individuality. So, the Swa-Twam-Tat inquiry investigates the individual self to uncover its true nature as Atman, which is identical to the universal Self (Brahman). Questioning the ego, discerning the eternal from the transient, and realizing the non-dual reality, one transcends the illusion of separation and recognizes the oneness of all existence.

Next, the concept of the relational self (Twam) in the context of Swa-Twam-Tat inquiry—a self-inquiry process rooted in Eastern and spiritual philosophy—refers to understanding the self not as an isolated entity but as deeply interconnected with others and the universe. This perspective emphasizes the relational nature of existence, highlighting that the self is not separate from the world but dynamically interwoven. Swa-Twam-Tat is the framework for exploring the nature of the self (Swa), the other (Twam), and the universal reality (Tat). The inquiry seeks to dissolve the illusion of separation between the individual self, others, and the ultimate reality, often referred to as Brahman in Advaita Vedanta. Swa represents the individual self or "I" that we identify with daily life, Twam signifies the "other," or the external world, including people, objects, and relationships, and Tat denotes the universal reality or ultimate truth underlying both the self and the other. The relational self emerges when we investigate the interplay between Swa (self) and Twam (other). It challenges the notion of an independent, isolated self and highlights existence's interconnected and interdependent nature. The self (Swa) cannot exist in isolation; it is always in relation to the other (Twam). For instance, our identity as a friend, parent, or teacher depends on our relationships with others. These relational dynamics reveal that the self is not a fixed entity but a fluid, context-dependent phenomenon. Hence, the Swa-Twam-Tat inquiry helps us see that the boundaries between self and others are artificial constructs of the mind. The self and the other are expressions of the same universal reality (Tat). In this regard, the relational self is a gateway to understanding the universal self (Tat). Through relationships, we experience love, compassion, and unity, which point to the underlying oneness of existence. For example, when we feel deep empathy for someone, we momentarily transcend the sense of separation and touch the universal self. Recognizing the relational self-fosters compassion, as we see others not as separate but as part of our own being. This understanding can lead to healthier, more harmonious relationships and serves as a stepping stone to realizing the universal self. To explore the relational self in the Swa-Twam-Tat inquiry, begin with self-reflection. Ask, "Who am I in relation to others?" to myself and observe how my sense of self changes depending on the context, such as being a parent, friend, or colleague. I reflect on the idea that my relationships shape your identity. Next, I engage in an inquiry into relationships. Examine a close relationship and ask, "Where do 'I' end and the 'other' begin?" Notice how the other influences our emotions, thoughts, and actions, and contemplate how the other mirrors our own consciousness. Finally, practice compassion by engaging in acts of kindness, recognizing that the other is not separate from us. This practice helps dissolve the illusion of separation and strengthens the sense of interconnectedness. The relational self (Swam) in Swa-Twam-Tat inquiry is a powerful lens for understanding the interconnected nature of existence. By exploring how the self is shaped and intertwined with others, we can move closer to realizing the universal self (Tat). This inquiry deepens my spiritual understanding, enriches relationships, and fosters a sense of unity with all beings. Ultimately, the relational self is a reminder that we are not isolated individuals but integral parts of a vast, interconnected whole.

The concept of the universal self (Tat) in the context of the Swa-Twam-Tat inquiry focuses on understanding the nature of the individual self (Atman) and its relationship with the universal reality (Brahman). The phrase "Swa-Twam-Tat" is a simplified representation of the Mahavakya (great saying) "Tat Tvam Asi", which translates to "Thou art That." This Mahavakya, one of the four primary statements in the Upanishads, points to the truth that the individual self (Atman) is identical to the universal self (Brahman). The inquiry begins with an exploration of the three components: Swa (Self), Twam (Thou), and Tat (That). Swa refers to the individual self, or Atman, which is the innermost essence of a person. It is often mistaken for the body, mind, or ego, but through self-inquiry (Atma Vichara), one realizes that the true self is beyond these temporary identities. The Swa is infinite, unchanging, and pure consciousness. Twam, on the other hand, represents the apparent self, the "you" identified with the body, mind, and ego in the waking state. This is the Jiva, the individual soul bound by karma, desires, and ignorance (Avidya). Through introspection, one comes to understand that the Twam is not the true self but a reflection of the universal self in the mirror of individuality. Finally, Tat signifies the universal self, the infinite, eternal, and unchanging reality that underlies all existence. It is the source and substratum of the universe. The inquiry leads to the realization that the individual self is not separate from the universal self; they are one and the same. This realization is encapsulated in the Mahavakya "Tat Tvam Asi" ("Thou art That"), which serves as a thoughtful pointer to this truth. The process of Swa-Twam-Tat inquiry involves self-questioning, meditation, and contemplation (Verghese et al., 2024). The researcher asks, "Who am I?" and investigates the nature of the "I" they identify with. This inquiry helps cover layers of false identification, such as the body, mind, and ego, to reveal the true self. Through meditation, scriptural study, and reflection, the seeker recognizes that the individual self is not separate from the universal self. This realization dissolves the sense of duality, revealing that all distinctions—such as self/other and subject/object—are illusions (Maya) and that only Brahman exists.

The finale of this inquiry is the direct realization of the universal self, where the researcher experiences their true nature as infinite, eternal, and one with Brahman. This state is known as Moksha (liberation). The Swa-Twam-Tat inquiry can be applied through meditation, where one focuses on the question "Who am I?" to transcend the ego and realize the true self. Contemplation on the Mahavakya "Tat Tvam Asi" helps internalize the truth of oneness. Once the universal self is realized, the researcher lives from that awareness, seeing all beings and the universe as expressions of the same Brahman. Thus, the Swa-Twam-Tat inquiry is a journey of self-discovery that leads to realizing the universal self. It involves questioning the nature of the "I," transcending the ego, and recognizing the non-dual truth expressed in the Mahavakya "Tat Tvam Asi." This realization brings about liberation (Moksha) and the experience of oneness with all existence, transforming the way one perceives and interacts with the world. Table 2 illustrates the key aspects of the Individual Self (Swa), Relational Self (Twam), and Universal Self (Tat) in the context of the Swa-Twam-Tat inquiry rooted in Advaita Vedanta:

Table 2

Key Aspects of the Swa, Twam, and Tat Inquiry

Aspect	Individual Self (Swa)	Relational Selves (Twam)	Universal Self (Tat)
Definition	The innermost essence of a being is often mistaken for	The self in relation to others and the external	The ultimate reality (Brahman), the infinite and eternal

	the ego or personality.	world, emphasizes interconnectedness.	source of all existence.
Nature	Eternal, consciousness, blissful, non-dual (Atman).	Fluid, context-dependent, and shaped by relationships.	Infinite, unchanging, and the substratum of the universe (Brahman).
Key Focus	Self-inquiry (Atma Vichara) to discern the true self beyond the body, mind, and ego.	Exploration of the interconnectedness between the self and others.	Realization of the non-dual truth that the individual self is one with the universal.
Core Inquiry	"Who am I?" – Peeling away false identities to realize the true self (Atman).	"Who am I in relation to others?" – Understanding the self as interdependent.	"Thou art That" (Tat Tvam Asi) – Realizing the oneness of Atman and Brahman.
Illusion (Maya)	The illusion of identifying with the body, mind, and ego (Avidya).	The illusion of separation between self and others.	The illusion of duality is where the universal self appears separate from the individual.
Practice	Meditation, self-reflection, and discrimination (Viveka) to separate eternal from transient.	Reflection on relationships, compassion, and seeing the other as a reflection of the self.	Meditation, scriptural study (Upanishads, Bhagavad Gita), and contemplation of "Tat Tvam Asi."
Goal	To realize the true self as Atman, transcending the ego and physical/mental limitations.	To recognize the interconnectedness of all beings and foster compassion and unity.	To realize the non-dual nature of reality and experience liberation (Moksha).
Outcome	Liberation from the fear of death and suffering, recognizing the self as eternal bliss.	Harmonious relationships and a deeper sense of unity with others.	Direct experience of oneness with Brahman, transcending all duality.
Key Statement	"I am the witness, not the doer."	"The other is not separate from me."	"Thou art That" (Tat Tvam Asi).
Role in Swa-Twam-Tat	The starting point of inquiry focuses on the individual self (Swa).	The bridge between the individual and universal, exploring the relational self (Twam).	The ultimate realization of the universal self (Tat), where all distinctions dissolve.

Thus, *Swa-Twam-Tat* is a philosophical inquiry rooted in Advaita Vedanta (non-dualism), exploring the unity of the individual self (Twam), universal reality

(Tat), and their intrinsic essence (Swa). The researcher, like me, is both the subject and the object of inquiry, seeking to realize their true self for inner transformation and spiritual realization that deepens spiritual understanding and self-awareness and integrates ancient wisdom with personal inquiry. The methodology is designed to explore the interplay between the individual self (Twam), the universal self (Tat), and their intrinsic unity (Swa).

Likewise, the Swa-Twam-Tat inquiry is a philosophical framework rooted in the ancient Eastern concept of 'Tat Tvam Asi', which emphasizes the unity of the individual soul (Atman) with the universal soul (Brahman) that highlights the interconnectedness of all existence and promotes relational ontologies, challenging the dominance of Western epistemologies by fostering a more inclusive and culturally sensitive understanding of knowledge. This inquiry integrates diverse cultural perspectives and knowledge systems, referred to as Gyāna Pranāli, to create a holistic approach to inquiry. The Swa-Twam-Tat Inquiry seeks to transcend dualistic perspectives, emphasizing the interconnectedness of the individual self (Swa), relational self as others (Twam), and the universal self as universal reality (Tat), and fostering a sense of unity and relationality in knowledge production. The Swa-Twam-Tat inquiry focuses on three primary dimensions of knowledge: Swa inquiry, Twam inquiry, and Tat inquiry (Dahal et al., 2024a). However, Dahal et al. (2024a) stated, "The Swa-Twam-Tat inquiry is more effective than autoethnography because it incorporates first-person, second-person, and third-person perspectives. In contrast, autoethnography divides the world into two parts, even though it claims to focus on the dialectical relation between self and culture." (p. 2.).

Thus, Swa inquiry involves first-person self-reflection, employing methods such as journaling, meditation, introspection, and autoethnography to explore the nature of the self. Twam inquiry engages with second-person participant interactions, employing techniques like interviews and collaborative inquiry to understand relationships and interconnectedness with others. Tat inquiry extends to the third-person exploration of broader contexts, using methods such as ethnography, field research, comparative studies, and document analysis to examine universal connections and cultural systems. Together, these methods create a comprehensive framework for understanding the self, relationships, and the universal reality among the community of 'I'. Thus, the ontological of the Swa-Twam-Tat inquiry promotes inclusivity and respect for diverse cultural and philosophical traditions, recognizing the importance of cultural and spiritual contexts in knowledge production and the epistemological goal is to explore the unity of existence through interconnected and reflective inquiry, emphasizing the idea that 'I exist because you are there.' This framework draws inspiration from the concept of 'Tat Tvam Asi' and aligns with the paths of Karma Yoga (action), Bhakti Yoga (devotion), Jnana Yoga (knowledge), and Raja Yoga (meditation). In practical application, the Swa-Twam-Tat inquiry encourages using methods such as autoethnography, collaborative inquiry, and meditation to explore personal and collective experiences (Dahal et al., 2024a).

Next, this inquiry bridges cultural, social, and spiritual dimensions of knowledge by integrating diverse knowledge systems into a holistic framework, fostering a deeper understanding of the interconnectedness of all beings. This approach challenges Western-induced epistemological dominance and offers a transformative pathway for individuals and communities to explore their place within the universal reality. The Swa-Twam-Tat inquiry provides a powerful tool for personal growth, cultural understanding, and spiritual realization through its emphasis on unity, relationality, and inclusivity.

Therefore, the Swa-Twam-Tat inquiry is an alternative research methodology for my inquiry that entails researchers writing about significant topics—including family, personal well-being, and professional development—while setting their experiences within a social context. In doing so, the Swa-Twam-Tat inquiry concept challenges the Western-induced perspective of dualism, which delineates the autoethnographic self (I, first-person) from culture (other, third-person). In my inquiry, I employed the I-thou-other approach in our non/dual (partly dual and wholly nondual) context of the three-fold classifications of persons. Swa (self) represents myself as both a practitioner and researcher. Twam (thou or you) refers to the intermediary space between self and other, acting as a connector or mediator. In this context, Twam includes my participants and critical friends who engaged with me and maintained an I-thou relationship during the inquiry process. Tat signifies the other, which may not be directly known but is referred to by readers and distant critics of my work. However, the blurred relationships between I, thou, and the other should be recognized. I represent Swa, claiming ownership and authorship of my texts. Simultaneously, as Twam, I engage in dialogue with my researcher self as a practitioner self, questioning how this methodology works in practice. As Tat (i.e., universal self), I have become a reader beyond my authorial spectrum, questioning why my authorial self-researched and wrote this way. In the years following this inquiry, as my consciousness evolves, I can converse with my authorly texts and question why the researcher could not do otherwise. This can be done by Twam (another self, connected with the first person) and Tat (the third person, who treats the text as and through distance).

This qualitative and transformative inquiry method has several key features: it alters our perception of time, requires vulnerability, fosters empathy, embodies creativity and innovation, breaks down boundaries, honors subjectivity, and provides therapeutic benefits (Custer, 2014). So, the Swa-Twam-Tat inquiry demands a deep exploration of individual experiences and grand narratives within oneself (Hayler, 2010) aligned to Twam-Tat. Swa-Twam-Tat is an approach in educational inquiry for change-driven orientations. This inquiry can be challenging because it encompasses a mix of methods, inquiry, and writing that aligns with ethical considerations, knowledge, and existence, taking care of their *Dharma* (duties as a researcher) and *Karma* (actions as a researcher) (Dahal & Luitel, 2022). Despite variations in focus, all inquiries aligned to Swa-Twam and Tat share a common goal: to make sense of their lived experiences in relation to the cultures they inhabit—whether through living, being, doing, or knowing (Keleş, 2022). As a researcher, I engaged with my research participants and a critical friend's emotional dimensions, emphasizing self, others, and culture. For me, Swa-Twam-Tat serves as a transformative tool for professional development. It transcends boundaries and honors subjectivity by fostering empathy, creativity, and innovation (Custer, 2014; Taylor et al., 2012). Likewise, Swa-Twam-Tat operates as an insider’s methodology, where our personal and professional experiences are the foundation of inquiry. Thus, “Swa-Twam-Tat” from Advaita Vedanta explores the understanding of the self (Swa), the other research participants and critical friend (Twam), and the ultimate reality or Brahman or readers (Tat). Swa refers to the individual self or ego, the sense of “I” that we all experience. Twam represents the other or the individual self in another person. Tat signifies the ultimate reality or Brahman, the unchanging, infinite, immanent, and transcendent reality that is the divine ground of all beings. The inquiry into “Swa-Twam-Tat” is about realizing that the individual self (Swa) and the other (Twam) are ultimately one with the ultimate reality (Tat), a realization often summarized in the Mahavakya (great saying) from the Upanishads: “Tat Tvam Asi” (That Thou Art), meaning the individual self is not different from the ultimate reality. Writing in Swa-Twam-Tat inquiry becomes a transformation, healing, and illumination process. Thus, Swa-Twam-Tat explored the interplay between self, others, and readers from the cultural and social context.

I have described how I am going to undertake my inquiry within Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda. This Gyāna Pranāli design space offered me new epistemologies of practice (i.e., ways of knowing, being, valuing, acting, and representing) while reporting autoethnographies (i.e., Swa) of quest and identity transformation (Grant & Lloyd-Parkes, 2024). Likewise, this design enables me to adopt Gyāna Pranāli to transform educational policies and practices. In this line, within the praxis of transformative research approach as/for Mokshā or liberation, which offers thick descriptions and a deep understanding of the phenomenon, I choose this inquiry as a research methodology as an educational practitioner to transform my (Swa), my research participants and critical friend (Twam) professional practices inviting readers (Tat) and envision the better life of the future generation. My inquiry examined my lived experiences, intending to develop a vision of STEAM-based mathematics education via non-positivistic ways of knowing as constructing, contesting, and creating (Luitel, 2009; Luitel, 2019). Thus, the use of Swa-Twam-Tat as a research methodology enabled me to develop a better understanding of the proposed issue under the phenomenon via my lived experience as a student, mathematics and technological teacher, researcher, and teacher educator representing the dialectical relationship between ethos, notions, and categories embedded in my practices as leaner, teacher and teacher educator. At this stage, the term Swa-Twam-Tat infers a dialectical relationship among self (me), others (research participants and the critical friend), and readers that is aligned with their culture. This dialectical relationship allowed me to describe my self-situated socio-cultural practices using first-hand observations, discussions, and participation as a form of self-culture.

Dialectical relationships equally allowed me, my research participants, and my critical friend to better examine their feelings, emotions, thoughts, and practices to understand the phenomenon under study. As a result, it helped me, my research participants, and my critical friend envisage STEAM-based mathematics education by incorporating non-dualistic, inclusive, and empowering visions, ideologies, and practices with multidisciplinary to transdisciplinary approaches. This process further allowed me to be aware of and adopt Ākhyāna writing as the process of inquiry.

Consequently, I became aware of my strengths and limitations in different stages of my personal and professional life as a student and teacher of mathematics and technology, teacher educator, and researcher. Table 3 illustrates the relationship between the philosophical, methodological, and practical dimensions of the *Swa-Twam-Tat* inquiry.

Table 3

Philosophical, Methodological, and Practical Dimensions of Swa-Twam-Tat Inquiry

Aspect	Description
Concept	Swa-Twam-Tat is a philosophical inquiry rooted in Advaita Vedanta, exploring the unity of the individual self (Swa), relational self (Twam), and universal self (Tat).
Researcher's role	The researcher is both the subject and object of inquiry, seeking self-realization for inner transformation and spiritual understanding.
Philosophical basis	Based on "Tat Tvam Asi," emphasizes the unity of the individual soul (Atman) with the universal soul (Brahman), integrating ancient wisdom with personal inquiry.
Methodology focus	Explores the interplay between the individual self (Swa), relational selves (Twam), and universal self (Tat), fostering relational ontologies.
Epistemological significance	Challenges Western epistemological dominance by integrating diverse cultural perspectives (Gyāna Pranāli) for holistic knowledge production.
Dimensions of inquiry	Swa inquiry: First-person self-reflection (journaling, meditation, introspection, autoethnography). Twam inquiry: Second-person engagement (interviews, focus groups, collaborative inquiry). Tat inquiry: Third-person broader exploration (ethnography, field research, comparative studies).
Ontological perspective	Promotes inclusivity and respect for diverse traditions, emphasizing interconnected and reflective inquiry with the idea: "I exist because you are there."
Alignment with Yogic paths	Aligns with Karma Yoga (action), Bhakti Yoga (devotion), Jnana Yoga (knowledge), and Raja Yoga (meditation).
Practical applications	Uses autoethnography, collaborative inquiry, and meditation to explore personal and collective experiences.
Impact on knowledge systems	Bridges cultural, social, and spiritual dimensions, fostering unity, relationality, and inclusivity in inquiry.
Methodological approach	Challenges Western dualism by integrating the I-thou-other approach in a non/dual context (partly dual, wholly non-dual).
Three-fold classifications	Swa: Researcher as both practitioner and researcher. Twam: Intermediary space (participants, critical friends) as relational self. Tat: Universal self (readers, distant critics).

Transformative research features	Alters perception of time fosters empathy, encourages creativity, breaks boundaries, honors subjectivity, and provides therapeutic benefits.
Inquiry orientation	A change-driven educational inquiry approach that integrates ethical considerations, knowledge, and existence (Dharma & Karma).
Insider's methodology	Uses personal and professional experiences as foundations for inquiry, emphasizing lived experiences in relation to culture.
Dialectical relationship	Explores interconnections among individual self (Swa), relational self (Twam), and universal self (Tat) through lived experiences, culture, and social context.
Influence on STEAM Education	Develop a vision for STEAM-based mathematics education by incorporating non-dualistic, inclusive, and transdisciplinary approaches.
Personal and professional reflection	Allows the researcher to examine strengths, limitations, and evolving consciousness as a student, researcher, teacher, and educator.

Likewise, Table 4 illustrates the interconnected nature of philosophical, methodological, and epistemological contexts of the Swa-Twam-Tat inquiry.

Table 4

Interconnected Nature in Philosophical, Methodological, and Epistemological Contexts of Swa-Twam-Tat Inquiry

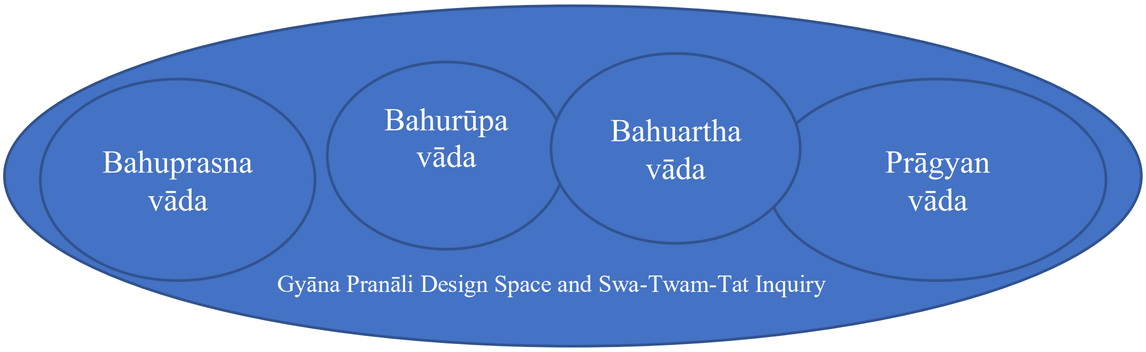
Aspect	Swa (Self/First-Person Inquiry)	Twam (Others/Second-Person Inquiry)	Tat (Universal/Third-Person Inquiry)
Definition	Exploration of one's own self, experiences, and reflections.	Engaging with others through dialogue, relationships, and shared experiences.	Understanding the ultimate reality and universal interconnectedness.
Philosophical roots	Advaita Vedanta, self-awareness, inner transformation.	Empathy, intersubjectivity, relational ontology.	Non-dual realization of unity with Brahman.
Methodology	Autoethnography, journaling, introspection, meditation.	Interviews, collaborative inquiry, focus groups, and dialogue.	Ethnography, comparative analysis, philosophical exploration.
Ontological perspective	Personal reality (I as an individual).	Negotiated reality (I-thou relationships).	Global reality (I-thou-other interconnections).
Epistemological goal	Self-awareness and realization of one's true nature.	Understanding the self through	Transcending duality to recognize

		engagement with others.	unity with universal consciousness.
Application in inquiry	Writing as inquiry, self-reflection, professional transformation.	Engaging with participants and critical friends in knowledge creation.	Bridging cultural, social, and spiritual knowledge systems.
Theoretical influences	Karma Yoga (action), Bhakti Yoga (devotion), Jnana Yoga (knowledge), Raja Yoga (meditation).	Ethical duty (Dharma) and relational engagement.	Tat Tvam Asi – realization of unity with the universe.
Influence of cultural perspectives	Hinduism: self-awareness and spiritual growth. Buddhism: momentariness and self-reflection. Gandhian philosophy: self-realization and liberation (Moksha).	Dialogic knowledge sharing, communal identity formation, audience engagement.	Ultimate truth, interconnectedness, Neti-Neti (beyond duality).
Connection to autoethnography	Personal narratives to understand self and experiences.	Engaging with participants and readers in meaning-making.	Positioning self, others, and knowledge within broader cultural and social contexts.
Key outcomes	Personal transformation, self-awareness, spiritual realization.	Relational understanding, ethical responsibility, and social awareness.	Holistic knowledge, interconnected existence, transcending duality.

However, the key similarities and differences between the two traditions of methodologies—in the East 'Swa-Twam-Tat' and in the West 'arts-based critical autoethnography and ‘Western’ multi-paradigm/integral research'—enhance readability and enable the ‘Western’ academic reader to understand better and value the counter-hegemonic and creative efficacy of the unique ‘Eastern’ cultural contribution of my Swa-Twam-Tat inquiry approach. Swa-Twam-Tat inquiry, arts-based critical autoethnography, and ‘Western’ multi-paradigm/integral research connect to the self in different ways: spiritually in Advaita Vedanta traditions, politically and performatively in autoethnography, and integratively in integral theory. These methodologies challenge positivist reductionism and are consistent with the view that more than one way of knowing exists. That subjective experience is a legitimate form of knowledge, but it underscores the transformative power of inquiry with the self. Likewise, these methodologies criticize self-centered thinking and promote personal, relationship, or societal change. However, there are differences in approach from their metaphysical and methodological attitudes. The Swa-Twam-Tat inquiry is rooted in a non-dual metaphysics seeking the spiritual realization of the self and beyond. However, art-based critical autoethnography is activist and decolonial; it is also about voice, power, and identity politics. Wilber (2005) meta-theoretical model, integral research tries to harmonize different paradigms, focusing on methodological pragmatism and multi-dimensional exploration. Swa-Twam-Tat emphasizes metaphysical monism and ascetic contemplation, while autoethnography gestures toward critical/postmodern relativism and aestheticization as political protest. Meanwhile, integral research refuses to fall into paradigm absolutism, seeking neither fusion nor transcendence of inner and outer realities—rather, exerting both integration of the inner and the outer as a way of being, a path of practice, and a mode of inquiry that is both synthetic and inclusive. Figure 6 shows the relationship between Gyāna Pranāli design space and Swa-Twam-Tat inquiry.

Figure 6

Gyāna Pranāli Design Space and Swa-Twam-Tat Inquiry



And Table 5 shows the key similarities and differences between the Swa-Twam-Tat inquiry, arts-based critical autoethnography, and 'Western' multi-paradigm/integral research.

Table 5

Key Similarities and Differences of Swa-Twam-Tat Inquiry, Arts-Based Critical Autoethnography, and 'Western' Multi-Paradigm/Integral Research

Dimension	Swa-Twam-Tat Inquiry	Arts-Based Critical Autoethnography (Interpretivist + Criticalist + Postmodernist)	'Western' Multi-Paradigm / Integral Research
Philosophical Tradition	Non-dual reality (*Brahman*), self-inquiry, illusion of individuality (*Maya*), unity of *Ātman-Brahman*	Lived experience as knowledge, power structures & social justice, deconstruction of "truth" and art as resistance & voice	Synthesis of paradigms, methodological pluralism, complexity & emergence, holistic reality, and western meta-theoretical / integral (Wilber, 2005)
Epistemology	Intuitive, experiential, self-revealing through consciousness	Relational, subjective, embodied knowing	Dialectical integration of paradigms and values both subjective experience and objective analysis, and integrative: combines empirical, interpretive, critical, and spiritual epistemologies
Ontology	Non-dualism (Advaita): Self (Swa), relational selves (Twam), and universal self (Tat) are one	Multiple realities constructed through lived experience	Holonic (part-whole); reality is layered (individual, cultural, systemic, spiritual)
Axiology (Value orientation)	Liberation (*Moksha*) from ignorance, ethics grounded in *Dharma* (duty) and non-harm (*Ahimsa*), and transcends individuality to realize unity	Emancipatory change & social justice, challenges power structures through personal narrative and values creativity, vulnerability, and activism	Pluralistic values – coherence across systems; balance of individual and collective good, Holistic understanding of complex phenomena, balances critique, interpretation, and transformation.
Purpose of Inquiry	Self-realization (Moksha), unity of Swa-Twam-Tat	Voice, agency, transformation, healing	Integral transformation of self, others (i.e., society, and systems)
Methodology	Contemplative, dialogic,	Narrative, visual, performative,	Multi-paradigm inquiry (empirical, interpretive,

	meditative self-inquiry, experiential practices	reflexive, critical engagement with power	critical, and spiritual methodologies)
Role of Researcher	Seeker of truth within; dissolves ego to realize unity	Reflexive, vulnerable, politically engaged storyteller and creator	Researcher as integrator, boundary-spanner across paradigms
View on Subject–Object Relationship	Non-dual: the knower, knowing, and known are unified	Interconnected: researcher and participants co-construct meaning	Nested/interdependent; multiple levels of subjectivity and objectivity
Approach to Truth	Satya as spiritual realization; truth is being and becoming	Truth as multiple, partial, situated, poetic	Integral truth: multidimensional and evolving
Ethical Grounding	Dharma (duty), Ahimsa (non-violence), and inner harmony	Ethics of care, justice, and decolonial responsibility	Integral ethics—transpersonal, cross-cultural, holarchic responsibility

Inquiry Spaces[13]

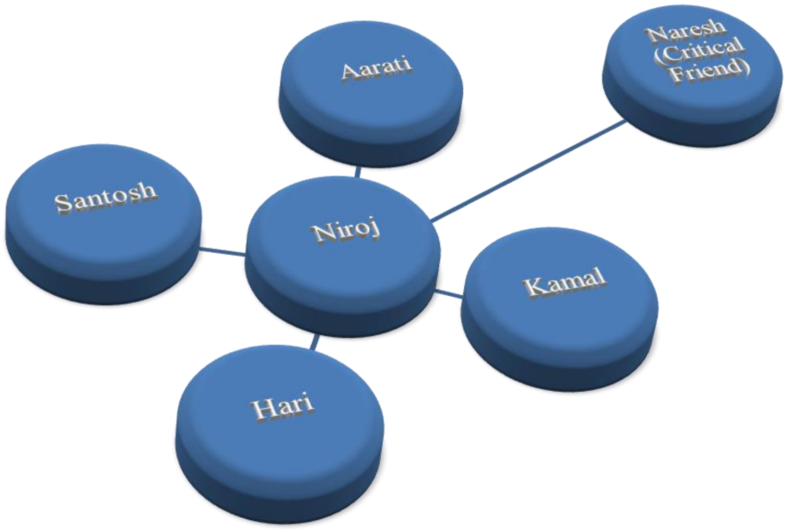
In my inquiry, the inquiry spaces were not restricted by boundaries due to the nature of the study. It required context-specific participants who were selected purposefully and adaptively (Dahal et al., 2024b). However, based on my inquiry purpose, my inquiry was confined to myself (individual self, i.e., Swa), four participants, a critical friend (relational selves, i.e., Twam), and readers (universal self, i.e., Tat). This limitation, however, suggested exploring the information through vāda, as Vāda is one type of discussion that is conducted with the help of Pramāṇas and Tarka (Gubrium & Holstein, 2003), connecting life and research as a Bahurūpavāda of multiplicity of *self* and *others*. Bahurūpavāda approaches encouraged me to uncover my multiple beliefs, thinking, and process of being and becoming in a larger context. Likewise, the main motto of my inquiry was to explore anecdotal and personal experiences of myself (insider), you as the dialogic bridge (readers), and others (culture), and connect autobiographical stories to wider cultural

[13] Disclaimer: Some section has been published at Dahal, N., Neupane, B. P., Pant, B. P., Dhakal, R. K., Giri, D. R., Ghimire, P. R., & Bhandari, L. P. (2024). Participant selection procedures in qualitative research: Experiences and some points for consideration. *Frontiers in Research Metrics and Analytics, 9*, 1512747. https://doi.org/10.3389/frma.2024.1512747

and social meanings and understandings to enrich the meaning-making process. Next, in my inquiry, I primarily generated field text, narratives, voices, and reflective notes from myself by incorporating the research participants and critical observations from a critical friend. My conversations were followed based on the narrative generated by myself with four research participants and a critical friend observation while envisioning the STEAM-based mathematics education on (1) school-community relations, (2) mathematical curricular spaces, (3) professional development, and (4) leadership development in STEAM-based mathematics education. In contrast, I was flexible regarding the number of research participants: first six, then five, and four. These were the basic tenets of my inquiry as per the emerging nature of the inquiry. Field text, narratives, voices, and reflective notes were generated and/or carried out before, during, and after the field engagements. I employed Ākhyāna writing as the process of inquiry to capture the contextual and universal perspectives in my inquiry. Field text, narratives, voices, and reflective notes were generated by incorporating the research participants and critical observations from the critical friend, which took almost 2 years (2021–2023) and other professional engagements while continuously envisioning the STEAM-based mathematics education, even in the finalizing stage of the thesis. Figure 7 illustrates my relational ontologies as the self of my research participants—Aarati, Kamal, Hari, and Santosh, and my critical friend—Naresh. The names and institutions they serve are pseudonyms.

Figure 7

Me and My Inquiry Participants



Niroj[14] is a doctoral student of STEAM education at Kathmandu University School of Education, Nepal. He also works at Kathmandu University School of Education, Nepal. Before that, he was working as a visiting faculty member of Kathmandu University School of Education (KUSOED) and Kathmandu University School of Arts (KUSOA), Hattiban, Lalitpur, Nepal, in M.Ed. in mathematics education, MPhil, and bachelor programs. In addition, he also worked as a visiting faculty member of Nepal Open University (NOU) under the faculty of social sciences and education, Manbhaban, Lalitpur, Nepal, in MPhil program. His research interests include ICT in education, qualitative research, mathematics education, open, distance & e-learning, STEAM education, alternative methodologies, and ICT & e-Research. He has been teaching graduate and undergraduate students for over a decade. He has also continuously participated in over three dozen national and international conferences, workshops, and seminars. He has published articles, books, book chapters, commentaries, editorials, and proceedings in various national and international journals and publication presses in mathematics and STEAM education.

Aarati is a secondary-level mathematics teacher in one of the private schools in Kathmandu Valley, Nepal. She is from the rural part of Nepal. She has been

[14] Disclaimer: Some bio information about Niroj has been posted at https://nsuworks.nova.edu/tqr/vol27/iss12/1/ on December 12, 2022.

involved in the teaching profession since completing her M.Ed. in Mathematics education in 2014 from one of the reputed universities of Nepal. She knows the pedagogical approaches to teaching and learning mathematics. But she does take care of other engagements to be professional, such as attending professional training and conducting the training in school.

Kamal has been in the teaching profession for more than three decades. He completed his master's degree in mathematics education in 2012. After completing master's degree, he has been engaged in the teaching profession. He has also been engaged as a seasonal teacher trainer to facilitate professional training for mathematics teachers in different parts of Nepal. He is the head of the mathematics department at his school in Lalitpur, Nepal.

Hari completed his MPhil degree at a reputed university in Nepal. After completing a B Ed in Mathematics education in 2009, he has been teaching. He is a permanent secondary-level mathematics teacher in one of the government schools in Lalitpur, Nepal. He has gained experience in teaching and learning by incorporating innovation. Likewise, he is also leading the mathematics department in the school. He has not limited his engagement to teaching and learning mathematics in school, but he has also been involved in offering professional training in different schools.

Santosh works as a secondary-level mathematics teacher at one of the government schools in Bhaktapur, Nepal. He completed B Ed, then MEd, and MPhil in Mathematics education. He completed a BEd in 2010. Besides being a secondary-level mathematics teacher, he has been a part-time lecturer at one of the campuses in Nepal. In school, he also served as the school's training head to facilitate the schoolteachers' professional development training. Offering ample opportunity for schoolteachers is one of the dreams to achieve in their profession. He is a passionate mathematics teacher who attempts to blend different strategies for school overall development by blending local and global knowledge in mathematics and wisdom.

Naresh is from a remote part of Nepal and struggled greatly in his past studies—SLC (now named SEE), intermediate, and Bachelor's. He completed his master's degree in mathematics education in 2018. After his master's degree, he has been engaged in private and public institutions to uplift his career in various positions. Continuing his studies, he also completed his MPhil in STEAM education in 2021 at one of the universities in Nepal. Likewise, he has been teaching various university-level courses. He has also presented some scholarly works at national and international conferences. His research interests are STEAM education, ICT and mathematics education. He believes in reflective practices to transform the meaningful engagement of the learners.

Next, in my inquiry, I largely generated field text, narratives, voices, and reflective notes from myself by incorporating the research participants and critical observations from the critical friend. My conversations were followed based on the narrative generated by myself with four research participants and critical friend observations while envisioning STEAM-based mathematics education on (1) pedagogical engagement, (2) mathematical curricular spaces, (3) professional development, and (4) leadership development in STEAM-based mathematics education (Gubrium & Holstein, 2003). In contrast, I was flexible regarding the number of research participants: first six, then five, and four. These were the basic tenets of my inquiry as per the emerging nature of the inquiry. I generated that before, during, and after the field engagements. I employed Ākhyāna writing as the inquiry process to capture the contextual and universal perspectives in my inquiry. Field text, narratives, voices, and reflective notes were generated by incorporating the research participants and critical observations from the critical friend, took almost two years (2021-2023), and other professional engagements, while continuously envisioning the STEAM-based mathematics education, even in the finalizing stage of the thesis. In Table 6 below, I presented a summary chart of my field text, narratives, voices, and reflective notes generation processes aligned with inquiry areas, representing chapters, narrative generation processes, and emerging research questions with field text, narratives, voices, and reflective notes and timeline, and theoretical referents that draw upon my lived experiences and field engagements.

Table 6

Narrative Generation Process, Inquiry Questions, and Sources of Field text, Narratives, Voices, and Reflective Notes

Inquiry Areas	Representing Chapters	Narrative Generation Processes	Inquiry Questions	Sources of Field text, Narratives, Voices, and Reflective notes	Theoretical Referents/ Perspectives	Tat Space (Universal Self)
Mathematical Curriculum Spaces: Synergy of Local and Global Knowledge for Producing Innovators	IV	Ākhyāna writing as the process of inquiry, uncovering my personal values, beliefs and practices, and writing narratives of my life worlds	How have mathematical curricular spaces been developed via the synergy of localization and globalization (i.e., glocalization) for producing innovative citizens?	Between Master degree than an MPhil degree and PhD (2011-2023) and four research participants, critical a friend	Curriculum images and metaphors (Schubert, 1986), Transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), critical pedagogy (Freire, 1970) and Swaraj perspective (Gandhi, 1909)	Educators and curriculum developers, students, parents and community members, educational researchers, policymakers and industry professionals

Pedagogical Engagement for Engaged Pedagogical Processes in Mathematics	V	Ākhyāna writing as the process of inquiry connecting roles as community facilitators of mathematics	How are engaged pedagogical processes practiced and envisioned in the school mathematics classroom?	Between MPhil and the first three years of my PhD engagements (2014-2023) and four research participants, a critical friend	Curriculum images and metaphors (Schubert, 1986), Transformative learning theory (Mezirow, 1991), Critical pedagogy (Freire, 1970), knowledge constitute interests (Habermas, 1972) and Swaraj perspective (Gandhi, 1909)	Teachers and educators, parents and community members, school administrators, students, educational researchers, and policymakers
Teachers' Professional Development Initiatives Around School Mathematics	VI	Conscious reflective writing, dialectical personal stories, metaphorical logic,	In what ways have change-driven teacher professional development initiatives around	Between master's degree, then MPhil degree and PhD (2011-2023) and four research	Transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), critical	Teachers and educators, professional development facilitators, students, school

		and poetic expressions	school mathematics been inclusive to both local and global perspectives?	participants, a critical friend	pedagogy (Freire, 1970) and Swaraj perspective (Gandhi, 1909) and participatory future studies (Ollenburg, 2019)	administrators, educational researchers, policymakers and community members
School Mathematics Leadership Development Processes	VII	Conscious, reflective writing, dialectical personal stories, metaphorical logic, poetic expressions, and visual representations	How has the leadership development process (teachers as change agents) been in place in areas of school mathematics education?	Between MPhil degree and PhD engagements (2014-2023) and four research participants, a critical friend	Transformative learning theory (Mezirow, 1991), critical pedagogy (Freire, 1970), Swaraj perspective (Gandhi, 1909) and participatory future studies (Ollenburg, 2019)	Teachers and educators, professional development facilitators, students, school administrators, educational researchers, policymakers and community members

Ākhyāna Writing as the Process of Inquiry[15]

My inquiry is a reflective process that navigates three interconnected dimensions: Self, Thou, and That. This inquiry is rooted in Vedic-Buddhist philosophy and emphasizes introspection, relational understanding, and non/dual realization (see **Chapters IV, V, VI and VII**). The meaning-making process extends beyond field texts and lived experiences, aligning with writing as both a process and a product of inquiry, incorporating Swa reflections, Twam reflections, and Tat reflections. It is constructed through the interpretation of phenomena, grounded in the axiological principles of Dharma (righteousness) and Moksha (liberation), the ontological assumption of non-dualism (Advaita Vedanta), which asserts the unity of the ultimate reality (Brahman) and the individual Self, and the epistemological approach of intuitive knowledge (Jnana) and scriptural authority (Shabda Pramana). This inquiry subscribed to an alternative paradigm, the Gyāna Pranāli framework, which integrates traditional philosophical systems with modern research practices. It synthesizes subjective and objective knowledge, aligning with Vedantic principles of unity and interconnectedness. My inquiry foregrounds the exploration of my experiences (the individual self), the perspectives of four research participants, and the insights of a critical friend (the relational selves), while also inviting readers (the universal self) into the dialogue. This framework provided the foundation for envisioning STEAM-based mathematics education in Nepal. Methodologically, the inquiry was guided by iterative reflexivity (Chang et al., 2013; Dahal & Luitel, 2023), involving critical reflections among all participants. The process incorporated multiple dimensions and rounds of meta-reflections, drawing from diaries, field notes, formal and informal discussions, vignettes, face-to-face dialogues, pre- and post-dialogue exchanges, short conversations, and reflective writings. Thus, by integrating spiritual wisdom, experiential knowledge, and academic rigor, the inquiry sought to bridge traditional and contemporary systems of knowing, offering a holistic approach to understanding and transformation.

My inquiry processes of unpacking my values, beliefs, and practices rely on reading and writing, and their meaning is merely aligned with conscious writing to report my *Dharma* and *Karma*. Conscious writing is a process of critical reflective

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[15] Disclaimer: Some sections of pp. 67-68, has been published at Understanding and encountering the ethics of self and others in autoethnography: Challenging the extant and exploring possibilities. *The Qualitative Report, 27*(12), 2671-2685. https://doi.org/10.46743/2160-3715/2022.5572

writing to exercise my free will by articulating my research problems through writing narratives—referred to as Ākhyāna writing. Ākhyāna refers to narrative or storytelling that unfolds cultural, philosophical, and spiritual insights. In inquiry, Ākhyāna serves as a tool for meaning-making, allowing me to unfold together personal experiences (as self), cultural contexts, and theoretical frameworks into coherent narratives (as Twam and Tat), where the richness of lived experiences and the depth of cultural understanding are primary sources of the information in the process of co-constructing knowledge through lived experiences, cultural contexts, and relational ontologies. Ākhyāna writing, thereby, analysis is embedded in the idea that truth is not fixed but emerges from the inquiry between the self and its context (Dhungana, 2022b), where my engagement with narrative creates a dialogic space for critical self-reflection and meaning making. So, Ākhyāna as a dialogic and reflexive praxis aligns with my inquiry, emphasizing three interconnected dimensions. The first, Swa (Self), focuses on reflexivity and the researcher's positionality. The second, Tawm (community), focuses on the importance of collective wisdom and participatory dialogue. Finally, Tat (context) underlines the socio-cultural and historical situatedness of the inquiry. Likewise, as articulated in classical texts like the Bhagavad Gita, meaning arises from the convergence of inner consciousness (i.e., ātma) with sensory experiences (i.e., Indriyas) and higher rationality (i.e., Buddhi). In such conceptualizations, the inquiry is a journey toward self-realization—a process of ‘being and becoming’ that the inclusive methodology, ‘Swa-Tawm-Tat inquiry,’ aims to uncover.

No doubt, in my inquiry, conscious, reflective writing practice is also the process of expressing my feelings, belongings, doubts, and pleasures in the forms of dialogic (i.e., understanding, growth, and co-creation of meaning) and dialectical (i.e., thesis, antithesis, and synthesis) personal stories. In my inquiry, these dialectical personal stories shaped my thinking, being, valuing, and doing. In this line, to capture the contextual and universal perspectives in my inquiry, I employed Ākhyāna writing as the inquiry process. Likewise, such ontology-driven writing strengthens my inquiry and allows me to generate thick descriptions of myself (Swa) and my research participants’ personal-professional practices (i.e., Bahuarthavāda), to develop professional praxis through critical self-reflection (i.e., Bahuprasnavāda), and to utilize arts-based methods in making sense of and expressing unfolding subjectivities (i.e., Bahurūpavāda). In contrast, writing is not only a method of expressing ideas but also helps me in meaning-making according to the context.

The meaning-making process in the inquiry is somehow complex and challenges the ethos of the conventional research meaning-making process. In the process of challenging the ethos of conventional research meaning-making process, the motto of my inquiry is to explore anecdotal and personal experiences of self (insider), you (readers), and others (culture) and connect this Ākhyāna to wider cultural, and social meanings and understandings to enrich meaning-making process (Ellis et al., 2010; Ellis et al., 2011). These processes require various layers of field texts (observations, interviews, memos, and notes) in the form of Ākhyāna writing aligned to the design space of unity in diversity. Ākhyāna writing positions myself as the center character, considering relevant literature and viewing it from the theoretical lenses of transformative learning theory (Mezirow, 1991), critical pedagogy (Freire, 1970), and Swaraj's perspective (Gandhi, 1909). Ultimately, this process generates evocative and contextual narratives but is not likely to be enough to capture the broad spectrums of field texts. Because of this limitation, field texts were generated in various ways. Among these various ways of generating field texts, to make my different ways of writing lively and viable via different logics and genres as a Rupavāda, I used dialectical, narrative, metaphorical, poetic, and visual logic and genres (Luitel, 2009). The maps and graphs in **Chapters I-VIII** illustrate visual logic and various genres.

The dialectical logic allowed me to create new spaces for envisioning STEAM-based mathematics education by promoting synergetic complementary world views (integrative, holistic, and inclusive) (Bakhurst, 2008; Ilyenkov, 2008; Luitel, 2009). Moreover, it helped me to balance the contradictory perspectives and values through continuous practices by critiquing others (Twam), you (readers—Tat), and self (Swa) in my inquiry. Likewise, in my inquiry, the narrative genre was an important means for thinking through multiple dimensions of Rupavāda. The narrative genre further helped me to promote mythos-centric thinking that integrates place, people, action, and time in generating field texts rich in cultural-contextual knowing, being, and valuing that make the events understandable in the process of the inquiry (Taylor et al., 2012; Forchtner, 2020). Similarly, the metaphorical logic in my inquiry enabled me to envision STEAM-based mathematics education by capturing the complexity of the phenomenon to explore the meaning of concepts and ideas. As an outcome, this logic offered me a platform for thinking and acting (Luitel, 2019) that makes my writing meaningful and understandable. In addition, poetic expressions in my inquiry offered me a space of imaginative aspects that are fundamental for exploring nonreal, felt, mythical, perceptual, imagistic, and atypical realities. Last, the visual genres in my inquiry helped me capture nonlinguistic genres to represent the phenomenon under study by incorporating photographs, paintings, cartoons, collages, and creative models. I employed these genres to demonstrate the multi-vocal, embodied, and nonlinear nature of knowledge claims aligned to inquiry. With this process of perspectival and layered exploitations, writing as/for the inquiry process shaped the quality of the meaning-making process and my inquiry.

In crafting narratives as part of the Ākhyāna writing as an inquiry process, I have utilized dialectical, narrative, metaphorical, poetic, and visual logics and genres (Dahal & Luitel, 2022; Luitel, 2009), which functions as a vāda—a method of debate, discussion, or dialectical reasoning aimed at uncovering truth through structured discourse, logical reasoning, and evidence. This approach serves as a foundation for meaning-making, particularly within the Swa-Twam-Tat framework (Dahal et al., 2024a). To generate meaning, I employed a multi-layered inquiry process. First, I engaged in first-person inquiry (Swa) through journaling, introspection, and autoethnography, allowing me to reflect deeply on my experiences and inner thoughts. Second, I conducted second-person inquiry (Twam) using interviews and collaborative dialogues to explore interpersonal dynamics and co-create collective insights. Finally, I applied third-person inquiry (Tat), incorporating ethnography, field texts, comparative studies, and document analysis to examine broader contextual and universal perspectives (Dahal et al., 2024a). This integrated approach, blending individual, interpersonal, and collective dimensions, provided a holistic understanding of the field text, narratives, voices, and reflective notes. I was able to generate rich, nuanced meanings from the field text and the lived experiences within the community of "I" by weaving together these layers of inquiry. This process deepened my understanding and highlighted the interconnectedness of personal, relational, and contextual knowledge in the pursuit of truth and insight. Figure 8 summarizes the process of meaning-making, and Figure 9 illustrates the overall process of my Swa-Twam-Tat inquiry.

Figure 8

Process of Meaning-Making

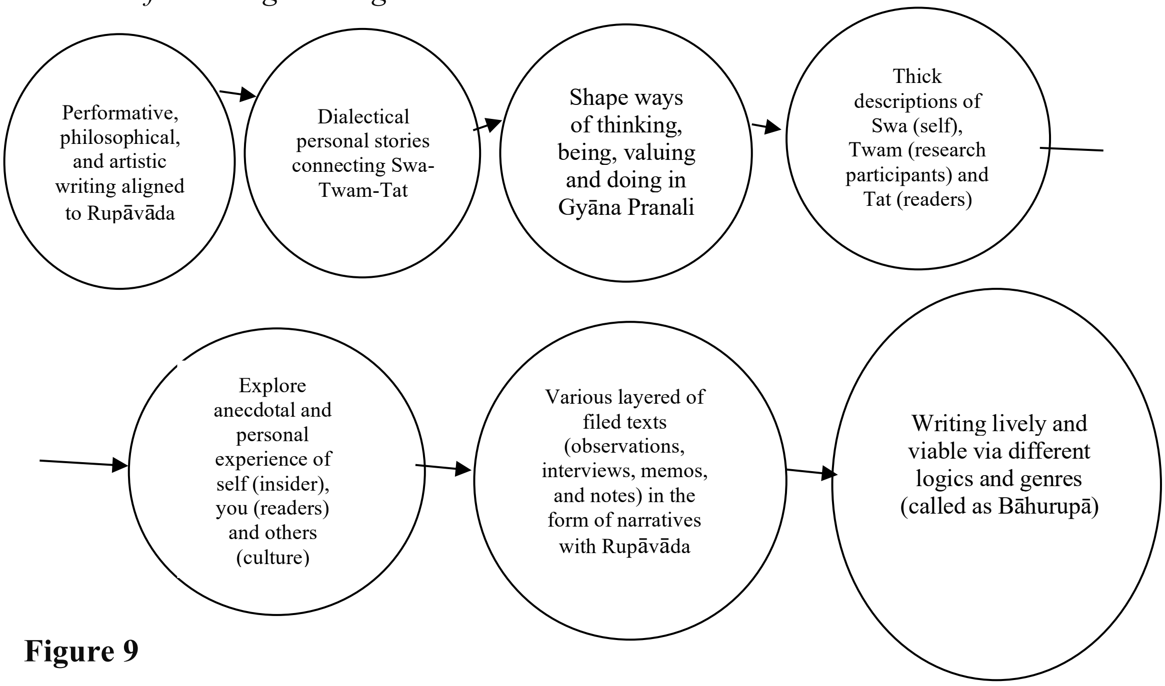
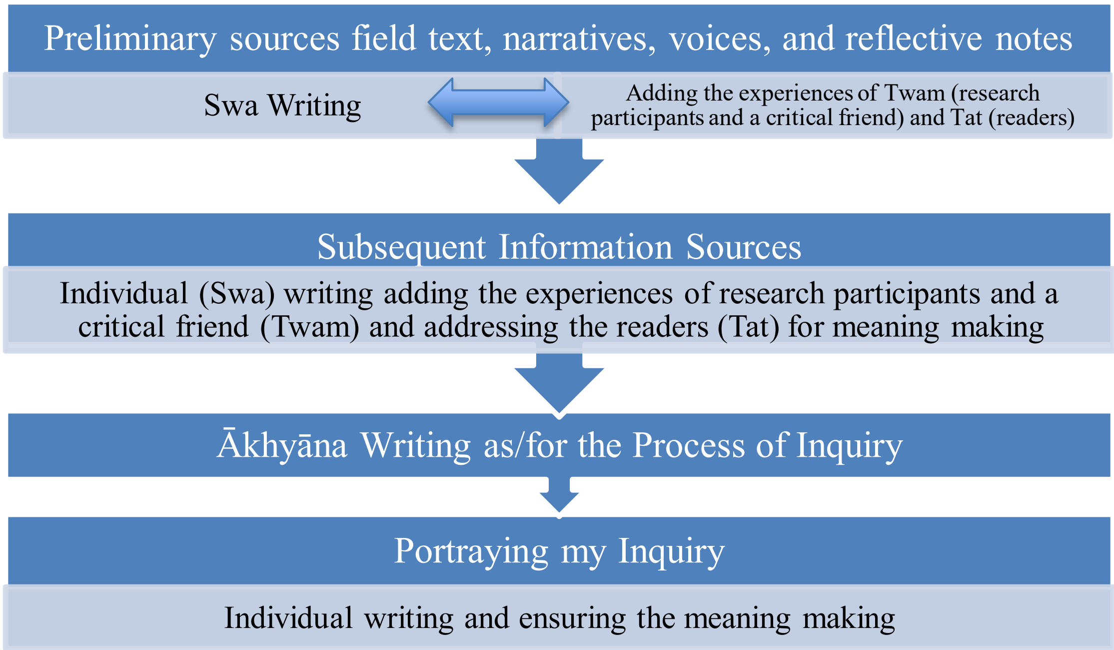


Figure 9

Process of my Swa-Twam-Tat Inquiry



Ensuring Quality of my Inquiry

Sometime around December 2021… I ask myself idly at around 4 o'clock in the afternoon, "Why is it important for qualitative researchers to consider quality standards? What standards of excellence apply to the qualitative study you are conducting or reading? What role does the researcher play in shaping the inquiry? In what ways do the people who are the focus of the study influence *and react to the insights? In inquiry, is generalization possible or desired, and how does this relate to data collection? How far could qualitative insights extend beyond the study's included data sources?" as I waited for the Ph.D. class on an early cool evening on one Friday in December 2021. As I sat and waited for class time, which was usually on time, this time, however, I found myself thinking back to something that had been discussed in our most recent session of Advanced Qualitative Research Methods with Professor Luitel: "How are you going to regulate your inquiry process?" As my thoughts continued: "How do I regulate the inquiry process?" my doubts were fighting back against my good spirits. (Personal Diary, 2021; Dahal, 2023a, p. 2299)*

The vignette above offered the different layers of my thinking regarding ensuring the quality of my inquiry. In this context, Kitto et al. (2008) emphasized that qualitative research and/or inquiry should address several criteria: clarification and justification, procedural rigor, representativeness, interpretative rigor, reflexivity and evaluative rigor, and transferability. In response to questions about why quality criteria matter to qualitative researchers and which criteria apply to my own inquiry, I discussed how qualitative research and/or inquiry outcomes and/or insights can be achieved and demonstrated to meet high standards in a thesis. So, the quality of my inquiry was regulated by comparing various forms and/or layers of field texts, narratives, voices and reflections. The field text, narratives, voices, and reflective notes achieved and/or demonstrated throughout the inquiry process to Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda through my inquiry enabled me to cultivate pedagogical and professional possibilities (Qutoshi, 2015). Logics such as dialogic, poetic, metaphoric, and narratives are some forms of layers generated through Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda using this inquiry. Likewise, these forms of logic and genres, as a Vāda hold six quality standards (Luitel, 2012; Taylor, 2014; Qutoshi, 2015), which would also be feasible for Swa-Twam-Tat inquiry:

> Incisiveness as focus on significant issue, illuminating as cultivating subtleties, verisimilitude as likeliness, transferability as viability, pedagogical thoughtfulness as evoking readers, and critical reflexivity as transformative process; are dialogical logic for complimentarily, metaphorical logic for multi-schema analysis and envisioning, poetic logic and genres for unpacking

ineffability, narrative logic and genres for diachronic representations and nonlinguistic logics. (pp.107-109)

In the Western tradition, the approach Guba and Lincoln (1985) is widely recognized when evaluating the quality of qualitative research, neglecting the Easter Wisdom tradition. However, Lincoln and Guba (1989) introduced an alternative set of criteria for assessing the quality of qualitative research. These criteria include credibility, transferability, dependability, confirmability, and authenticity. While Guba and Lincoln (1989) approaches are praised for its comprehensive consideration of the interpretive nature of qualitative research, they are also criticized for being overly complex and challenging to apply in practice. Despite these challenges, their method remains a valuable tool for assessing the quality of qualitative reports. Researchers like me to continue using these criteria to create a more rigorous and credible qualitative inquiry. However, Levitt (2021) contends that qualitative generalization should focus not on the entire population but on the specific phenomenon under investigation. In other words, the purpose of qualitative inquiry is to gain a deep understanding of a particular phenomenon, and the insights derived from such inquiry can be relevant to other similar phenomena, even if they cannot be broadly generalized to the entire population. However, ensuring the quality of Swa-Twat-Tat inquiry within the framework of Eastern wisdom traditions of Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda involves a deep commitment to self-awareness and mindfulness. Even Buddhism and Hinduism emphasize the importance of introspection and the continuous pursuit of self-knowledge. Engaging in regular critical reflection is crucial to maintaining the integrity of my inquiry, allowing Swa to connect with my inner self and the universal truths (Twam-Tat).

Ensuring the quality of my Swa-Twam-Tat inquiry requires a deliberate and systematic approach that aligns with the principles of rigor, reflexivity, and ethical engagement to report the Dharma and Karma of the overall process of my inquiry. I establish methodological rigor to maintain and enhance the quality of my inquiry. I use triangulation—employing multiple methods and sources of field text, narratives, voices, and reflective notes, such as journaling, interviews, and ethnography—to cross-validate insights and ensure credibility. I also prioritize transparency by clearly documenting my research process, including how I applied the Swa-Twam-Tat framework, so others can trace my steps and assess the validity of my work.

Additionally, I practice reflexivity by continuously reflecting on my positionality, biases, and assumptions, particularly in first-person inquiry (Swa), to ensure authenticity and self-awareness. Balancing the three dimensions of inquiry—Swa, Twam, and Tat—is essential for me to achieve a holistic understanding. In Swa (First-Person Inquiry), I ensure depth by consistently journaling, engaging in introspection, and using autoethnography to examine my experiences critically. For Twam (Second-Person Inquiry), I foster trust and openness in interpersonal interactions during interviews, actively listening to co-create meaning and accurately represent participants' perspectives. In Tat (Third-Person Inquiry), I contextualize my insights within broader social, cultural, and theoretical frameworks, using ethnography and comparative analysis to ground my work in universal and contextual realities. I engage in an iterative and reflective process, revisiting my outcomes and/or insights at each stage to refine interpretations and ensure coherence. I use reflective practices like peer debriefing or members to ensure the quality of my interpretations and enhance trustworthiness. I holistically integrate insights from Swa, Twam, and Tat, exploring connections and tensions between personal, interpersonal, and contextual dimensions to create a comprehensive understanding. To deepen the conceptual rigor of my work, I ground my inquiry in relevant theoretical and philosophical frameworks purposed in chapters—**I and III**. When presenting my insights, I aim to honor the richness of the Swa-Twam-Tat framework by using narrative, metaphorical, or visual representations to convey its multi-layered nature. I also seek feedback from peers, mentors, or the academic community to refine my work and ensure its relevance and impact. I can ensure the quality, depth, and integrity of my Swa-Twam-Tat inquiry, making it a meaningful contribution to both personal and collective knowledge by adhering to these strategies.

Additionally, seeking guidance from Twam and Tat from sacred texts can provide valuable insights and help me stay aligned with compassion, humility, and balance. For fostering a disciplined and open-minded approach, Swa-Twat-Tat inquiry remains authentic and deeply rooted in the rich traditions of Eastern wisdom. To enhance and/or ensure the quality of my inquiry within the framework of Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda, I have examined Pramāṇa and Sarvavyāpakatva in Bahuarthavāda lens; Vichārśīl Darśan, Vimarsha and Vichāra-dṛṣṭi-parīkṣā in Bahuprasnavāda; and considered aspects of

Prakāśa, and Satya-Anubhuti in Bahurūpavāda, and explored Pūrṇatva in Prājyanvāda are considered.

Pramāṇa

Bahuarthavāda within the Swa-Twam-Tat inquiry, emphasizes the multiplicity of meanings and the interconnectedness of diverse perspectives; the parallel term to credibility is "Pramāṇa." In Eastern philosophy, Pramāṇa refers to the means or sources of valid knowledge, encompassing the tools and methods to establish truth and understanding (Łucyszyna, 2023). Pramāṇa aligns with the concept of credibility, ensuring that the knowledge generated is trustworthy, valid, and grounded in reliable evidence. Bahuarthavāda, which acknowledges that truth and understanding can emerge from multiple perspectives and interpretations, relies on Pramāṇa to ensure that these diverse meanings are not arbitrary but are supported by rigorous and valid processes of inquiry. This maintains the credibility of the insights while embracing the richness of human experiences. Pramāṇa fits as a parallel to credibility because it authenticates the multiplicity of meanings (Bahuarthavāda) by grounding them in reliable sources of knowledge. It emphasizes using legitimate methods—such as perception, inference, and testimony—to establish truth, mirroring the rigorous processes used in my inquiry to ensure credibility. Furthermore, within my inquiry, Pramāṇa supports the integration of diverse perspectives (Swa, Twam, Tat) by ensuring that each perspective is justified through credible means. Related terms such as Satyata (truthfulness or authenticity) and Vishvāsniyatā (trustworthiness) further reinforce this alignment, as they emphasize the genuineness and reliability of the insights. In the Bahuarthavāda, Pramāṇa serves as the ground for establishing the credibility of the multiple meanings and interpretations that emerge from the interplay of Swa (Self), Twam (Thou), and Tat (That). It ensures that the inquiry remains rigorous, trustworthy, and grounded in convincing insights, while it embraces the diversity and complexity of human experiences.

Likewise, I looked at Pramāṇa as a quality standard of Bahuarthavāda by asking—how could you trust me as an inquirer? The process had to be believable and suitable for myself (Swa), you (readers, i.e., Tat), and others (Twam) so that it was convincing and credible in every scenario. With the visibility and intentions of being freely exposed in the research process and report, this quality standard expected integrity from me as the inquirer (Dauphinee, 2010). Usually disregarded or taken for granted in the research, Pramāṣa was investigated to ensure it was appropriate in my design space (Dauphinee, 2010).

Vyāpakatva

Bahuarthavāda within my inquiry, the parallel term to transferability—a concept in my inquiry that refers to the extent to which insights can be applied or partly generalized to other contexts—can be understood as Vyāpakatva. The term emphasizes the applicable nature of insights gained through the inquiry (Chari, 1994). Applicability reflects the ability of insights derived from one context to extend and resonate across diverse situations, cultures, or settings. It can be moved, transferred, or used in different situations, though the meaning depends on the context. Similarly, Vyāpakatva, which denotes "presence" or "pervasiveness," features the potential of the inquiry's insights to permeate and illuminate multiple dimensions of human experience, societal values, and glocal truths. Both concepts align with transferability by underlining the relevance and applicability of the inquiry's outcomes, ensuring that the insights are not confined to a single context but can be meaningfully extended to others. Within the Swa-Twam-Tat inquiry, Bahuarthavāda (multi-meaning) focuses on deriving rich, layered insights that are not limited to a single interpretation or context. Thus, the concepts of Vyāpakatva serve as philosophical parallels to transferability, ensuring that the meanings and understandings generated through the inquiry are contextually fluid (capable of adapting to diverse settings), universally relevant (reflecting truths that transcend individual experiences and apply to broader human and societal contexts), and philosophically grounded (rooted in the Vedantic principles of unity (Advaita) and interconnectedness). These principles inherently support the transferability of insights, making them applicable across varied domains and situations. Thus, in the Bahuarthavāda framework of the Swa-Twam-Tat inquiry, Vyāpakatva emphasizes the universal applicability and pervasive relevance of the inquiry's insights.

For instance, I examined Vyāpakatva as another quality standard of Bahuarthavāda with the question: How can you value the usefulness of my entire research process to others (Luitel, 2012)? Thus, the Vyāpakatva in my Swa-Twam-Tat inquiry attempted to provide rich details of the context, events, and movements that I experienced while implementing the research process. As a result, readers (e.g., Tat) recognized the Vyāpakatva of my research process in their context. Likewise, my vision for STEAM-based mathematics will be helpful for the readers.

Vichārśīl Darśan

A parallel term to pedagogical thoughtfulness as "Vichārśīl Darśan" aligns with the idea of thoughtful, reflective, and inquiry-based engagement, which refers to an inquisitive and reflective intellect seeking to explore, question, and understand multiple subject dimensions. It embodies a spirit of curiosity and a desire for deeper knowledge, mirroring the mindful and caring approach of Vichārśīl Darśan, where exploration and understanding from multiple angles are highly valued. Similarly, Vichārśīl Darśan signifies a reflective and contemplative perspective that critically examines ideas, questions, and experiences, emphasizing deep thinking and the integration of diverse viewpoints. This aligns with the reflective and empathetic nature, which focuses on understanding and responding to the needs and perspectives of learners with respectful and thoughtful engagement in dialogue, where multiple voices and perspectives are valued and explored, highlighting the importance of meaningful conversations in the learning process, paralleling the idea of creating a supportive and inclusive learning environment where dialogue and reflection are central to the educational experience. In my inquiry, this integration unfolds across the three dimensions of Swa-Twam-Tat. In Swa (Self), the researcher or educator engages in self-reflection (Jigyāsu Buddhi) to understand their own biases and assumptions. In Twam (Thou), through Samvāda Śraddhā, meaningful dialogues are fostered with participants, valuing their perspectives and experiences. Finally, Tat (That) enables the integration of diverse viewpoints, leading to a holistic understanding of the subject under inquiry. Thus, Vichārśīl Darśan reflects the thoughtful, reflective, and inquiry-driven approach that is central to both concepts.

Hence, this standard is rooted in Vichārśīl Darśan under Bahuprasnavāda with the question, how would Swa reflect and examine Swa-Twam-Tat existing practices as a teacher, parent, school leader, and researcher? Thus, this inquiry's pedagogical thoughtfulness helped me become aware of deep-seated assumptions guiding their values (Van Manen, 2016; Luitel, 2012; Taylor, 2014). Likewise, I attempted to generate evocative, perspectival, and genre-based texts for readers to engage in my research process and to make them conceptualize my vision for STEAM-based mathematics education. That will help the readers engage with my research texts and reflect upon their perspectives.

Vimarsha

Vimarsha within Bahuprasnavāda emphasizes multi-questioning and exploring diverse perspectives. The term—Vimarsha aligns with the idea of deep, critical reflection and introspection, which are central to the process of questioning and understanding in a holistic and relational manner. So, Vimarsha refers to the process of critical examination, deliberation, and thoughtful analysis, involving questioning, reflecting, and engaging deeply with ideas, perspectives, and experiences (Baindur, 2023). It mirrors critical reflexivity by encouraging myself as an inquirer to rigorously examine assumptions, biases, and positionality, fostering a process of intellectual and spiritual inquiry that seeks to uncover deeper truths. Similarly, Vimarsha signifies deep reflection, contemplation, and introspection, representing the internalization of knowledge and its critical examination to gain clarity and insight into the iterative and reflective nature of critical reflexivity, where I continuously question and refine my understanding through internal dialogue and self-awareness using my Viveka. Viveka refers to the ability to discern between the real (Satya) and the unreal (Mithya), the eternal and the transient. It involves critical thinking and the capacity to differentiate between various perspectives and truths. In the context of Bahuprasnavāda, Viveka complements critical reflexivity by enabling me to critically evaluate and navigate the diverse questions, perspectives, and interpretations that arise during the inquiry. These concepts—Vimarsha and Viveka—represent the essence of critical reflexivity within the Swa-Twam-Tat inquiry. In my inquiry, Vimarsha encourages me to critically examine and deliberate, question assumptions, and explore multiple angles of inquiry. Meanwhile, Viveka provides the discernment needed to differentiate between the diverse perspectives and truths uncovered during the inquiry. Thus, Vimarsha and Viveka emphasize critical examination, deep reflection, and discernment in the process of multi-questioning and relational inquiry.

Vimarsha involves becoming acutely aware of the limitations of my (Swa) chosen epistemological stance(s) and addressing personal and methodological concerns highlighted in my reflexivity notes and theoretical references. This process includes exposing Swa's biases and being conscious of Swa subjectivity (Palaganas et al., 2017; Shrestha, 2018). Drawing on Luitel (2009, 2012), Taylor (2014), and Shrestha (2018), the Bahuprasnavāda Gyāna Parnāli, I maintained the quality standard of my inquiry through Vimarsha by (i) making the process of interpretation visible to readers (e.g., Tat); (ii) critically reflecting upon my assumptions; and (iii) consciously and critically reflecting upon my evolving subjectivities (false consciousness) throughout the process of the Swa inquiry.

Vichāra-dṛṣṭi-parīkṣā

Vichāra-dṛṣṭi-parīkṣā involves questioning ideological frameworks, much like the practice of ideology critique in Western philosophy. Similarly, Dṛṣṭi-viveka emphasizes the discernment (viveka) of viewpoints (dṛṣṭi), focusing on distinguishing between true and false or conditioned and unconditioned perspectives. This is similar to deconstructing ideologies to uncover their underlying assumptions and limitations. In the Swa-Twam-Tat inquiry, the goal is to understand the nature of reality by examining the individual self (Swa), the relational selves (Twam), and the universal self (Tat). This process inherently involves critiquing and transcending limited or conditioned ideological frameworks to unravel and move beyond the constraints of rigid or unexamined worldviews.

The standard of Vichāra-dṛṣṭi-parīkṣā under Bahuprasnavāda as a *learning process crucial to realizing the phenomenon* focuses on how learners recognize and challenge ideological domination and manipulation (Brookfield, 2001; Taylor, 2014). Thus, in my Swa-Twam-Tat inquiry, the Vichāra-dṛṣṭi-parīkṣā helped me become aware of the learning process and assumptions. Consequently, I attempted to generate evocative, perspectival, and genre texts for readers to engage the participants in my research process and to conceptualize my vision for STEAM-based mathematics. That is helpful for the readers (e.g., Tat) to engage in my field texts and reflect upon their perspectives as a learning process. Furthermore, Vichāra-dṛṣṭi-parīkṣā in the inquiry examined and unpacked the underlying ideologies that shaped my personal and cultural narratives. Through this process, the inquirer like me was able to critically assess how larger societal structures and power dynamics affect our experiences and stories. Thus, Vichāra-dṛṣṭi-parīkṣā helped to reveal the often-implicit assumptions and beliefs that inform one's perspective. This process enabled a deeper understanding of how these vichāra affect Swa and Twam-Tat's collective experiences.

Prakāśa

Prakāśa represents the inherent light of the Self (Ātman), which has the capacity to reveal itself and all other phenomena without relying on any external source of illumination (Schmücker, 2019). Within the Swa-Twam-Tat inquiry, Prakāśa aligns with the understanding that the Self is the ultimate source of all illumination and knowledge. In the framework of Bahurūpavāda, where reality is perceived as multifaceted, Prakāśa functions as the illuminating principle that unveils the diverse and manifold forms of existence. Thus, while enriching and making more complex meaning of issues of my Swa-Twam-Tat inquiry, the quality standard of Prakāśa under Bahurūpavāda, illuminated significant research issues by accounting enrichment, vividness, and complexity. Likewise, the accounting was/were done through narrative, reflective, performance, poetic, and non-linguistic logic and genres (Luitel, 2009, 2012; Taylor, 2014) as Vāda explored the performative, philosophical, and artistic transformation (Dahal, 2023c; Dahal, 2024b; Grant, 2023).

Satya-Anubhuti

Satya-Anubhuti emphasizes the authenticity and depth of understanding that emerges from introspection, relational dialogue, and non-duality realization. At its core, Satya-Anubhuti seeks to harmonize the truths of the individual, relational, and universal selves, reflecting the interconnectedness of all dimensions of existence (Singh, 2010). This harmony ensures that participants' stories, reflections, and insights are represented authentically, without distortion or misalignment with their lived experiences, as truthfulness in the narrative. However, Satya-Anubhuti goes beyond surface-level truth to encompass the thoughtful realization of non-duality, where the individual self (Atman) and the ultimate reality (Brahman) are understood as one. This deepens inquiries like mine to align with the philosophical foundations of Vedanta, bridging the gap between subjective insights (personal experiences) and objective knowledge (universal principles). In doing so, it creates a holistic understanding that resonates with both individual and collective truths. Thus, Satya-Anubhuti ensures that the outcomes of the Swa-Twam-Tat inquiry are credible and meaningful, grounded in the ethical and philosophical principles of Dharma (righteousness) and Moksha (liberation). A key aspect of Satya-Anubhuti is its emphasis on reflexive alignment, where I engage in continuous critical reflection to ensure interpretations and representations align with the deeper truths of Swa, Twam, and Tat. This mirrors the iterative process of achieving Satya in my inquiry, where the goal is to refine understanding and representation until they resonate with reality. In my inquiry, Satya-Anubhuti manifests in various ways within the Swa-Twam-Tat inquiry. For instance, when participants share their narratives, Satya-Anubhuti ensures that these stories are truthful and resonate with more philosophical and spiritual truths. Similarly, I interpret field text, narratives, voices, and reflective notes through the lens of Satya-Anubhuti, ensuring that my insights reflect the interconnectedness of individual, relational, and universal dimensions. This ensures that the inquiry process and outcomes resonate with the participants and broader universal truths, creating a meaningful and transformative exploration of human experience!

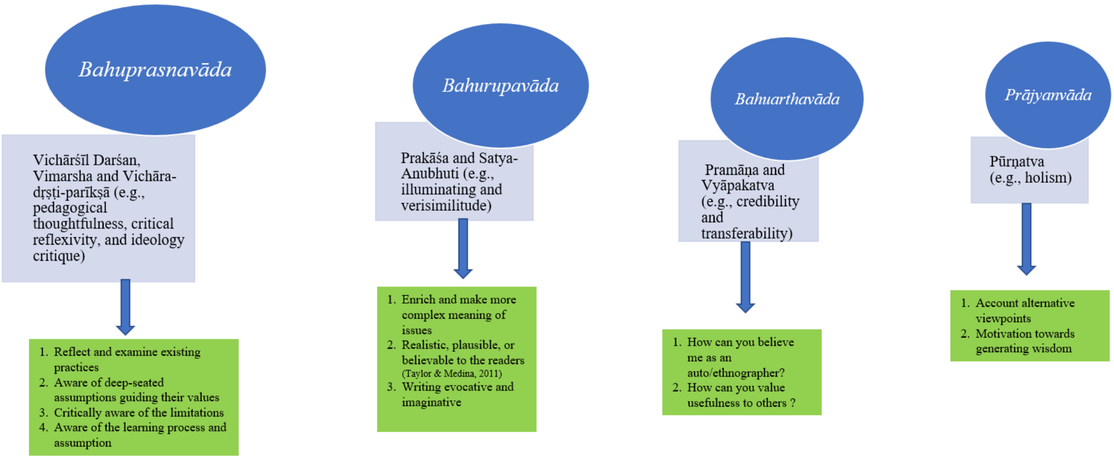
Hence, Satya-Anubhuti is the quality of appearing to be true or real, which informs me to articulate my stories and vignettes to be more believable and/or lifelike; as a result, the readers shall be engaged by connecting to their own phenomenon. Likewise, adhering to the quality standard of Satya-Anubhuti under Bahurūpavāda, I wrote narratives, vignettes, and stories by using different genres to make my inquiry texts realistic, plausible, or believable to the readers (e.g., Tat) (Dahal, 2023a; Taylor & Medina, 2011). Subscribing to Ākhyāna writing as the process of inquiry encourages me to describe the phenomenon thickly. In this line, Satya-Anubhuti supports in making my writing more evocative and imaginative. I even mimic the dialogues and vividly imagine the scenes. This phenomenon occurs when the narratives possess an element of Satya-Anubhuti or when researchers like me skillfully integrate lifelikeness into their storytelling. The similar experience unfolds verisimilitude as a reference to the resemblance of these narratives to real life, making them believable and relatable. As informed by Bahurūpavāda, I adhered to the Satya-Anubhuti quality standard as part of my approach. This involved incorporating situations and insights that readers (i.e., Tat) would find credible to connect to lives and research (Dahal et al., 2022b). I explored various aspects that allowed me to present my stories and events through multiple voices. These narratives were richly detailed, providing thick descriptions of the places, contexts, and the people directly or indirectly involved. I aimed to authentically unpack my pedagogical engagements and experiences to maintain the Satya-Anubhuti. I presented my stories and narratives with honesty and truthfulness. In doing so, I even invited readers (Tat), research participants, and a critical friend (Twam) to assess the authenticity of my accounts by relating them to their own contexts and socio-cultural practices. This approach allowed me to connect my narratives to the personal and professional contexts of others, fostering a deeper understanding and engagement.

Pūrṇatva

Pūrṇatva within Prājyanvāda signifies the idea of completeness or wholeness, where the Self (Swa), the Thou (Twam), and the Absolute (Tat) are seen as interconnected and inseparable parts of a unified whole aligned to the principle of oneness or non-duality, emphasizing the holistic integration of all existence. In Prājyanvāda, holism is reflected in the understanding that the individual (Swa), the other (Twam), and the universal (Tat) are not separate entities but are intrinsically connected, forming a unified, holistic reality. This aligns with the holistic worldview, where the ultimate truth is the non-dual, all-encompassing Brahman. Figure 10 below shows the process of ensuring the quality of the Swa-Twam-Tat inquiry.

Figure 10

Process of Ensuring Quality of My Swa-Twam-Tat Inquiry



My Ethical Considerations

Swa-Twam-Tat inquiry, deeply rooted in Vedantic philosophy and emphasizing introspection, relational understanding, and non-duality, necessitates careful attention to several ethical considerations to ensure the inquiry process's integrity, respect, and trustworthiness. Thus, relational ethics play a critical role in the Swa-Twam-Tat inquiry, as the process emphasizes the interconnectedness of Swa (Self), Twam (Thou), and Tat (That). Building mutual respect and trust between myself and the participants is essential to avoid exploiting the relational dynamic for personal or academic gain. So, reciprocity is also important, as participants must feel valued for their contributions through feedback, shared insights, or other forms of acknowledgment. Furthermore, the inquiry followed the Vedantic principles of cultural and spiritual integrity, such as Dharma (righteousness) and Moksha (liberation), ensuring these concepts are neither misrepresented nor diluted as I approach with humility and respect, avoiding any form of cultural or spiritual appropriation. Transparency and reflexivity are equally vital as I critically reflect on their own biases, assumptions, and positionality, particularly when interpreting participants' experiences through the lens of Swa, Twam, and Tat. So, the iterative nature of reflexivity requires continuous evaluation of the ethical stance and adaptation of the inquiry approach as needed. The principle of non-duality (Advaita) further features the importance of inclusivity, urging myself to recognize the interconnectedness of all beings and ensure that no voices are marginalized. Balancing subjective, relational, and universal perspectives (Swa-Twam-Tat) is key to avoiding privileging one dimension over others. Likewise, I ensure that participants' voices are accurately represented and not distorted for aesthetic or academic purposes when using creative methods such as vignettes, poems, or reflective writings. Participants retain ownership of their creative contributions, and their consent was obtained for using these materials in publications or presentations. Ethical considerations also extend to beneficence and non-maleficence, where researchers must minimize emotional, psychological, or cultural harm to participants, particularly when exploring sensitive topics related to human experiences, societal values, and justice. At the same time, the inquiry aims to maximize benefits, contributing positively to participants' understanding of themselves and their relationships and broader academic and societal discourse.

On the whole, in my *Swa-Twam-Tat* inquiry, I grappled with three key relational ethical domains—navigate the ethical implications of representing self (Swa) and others (Twam and Tat) in writing and self-care while critically reflecting on experiences and/or engagements and bear the responsibility of being ethical toward readers by engaging them dialogically and inviting them into their world (Dahal & Luitel, 2022; Ellis, 2007). Likewise, this inquiry holds ethical obligations, being authorial power. This authorial power allows Swa to portray the *Drama* and *Karma* of self and research participants included in my texts (Dahal & Luitel, 2022). Interestingly, this responsibility transcends the chaotic complexity of actions, where I challenge the status quo, injustices, and inequalities without causing harm to themselves or others. However, ethical considerations are often transferred to an afterthought at the end of the methodology section. This contradicts the overall process of reflecting *Dharma* (i.e., duty) and *Karma* (i.e., action) throughout the inquiry. Instead, in my inquiry, ethical principles are reflected and visible from inception to the final stage, addressing potential difficulties and vulnerabilities in the processes, ethos of writing, and meaning making (Dahal & Luitel, 2022).
Likewise, as an inquirer, I am the major source of exploration. This is a legitimate methodology for the research project. Likewise, Swa-Twam-Tat has emerged as an

important methodology in the social sciences for contributing to phenomena to understand human actions and concerns. In doing so, the inquiry is a form of therapy, in general, in the best case, and a form of narcissism, solipsism, and aestheticism, in particular, in the worst case, for challenging and critiquing the established theoretical standpoints. To this end, vulnerability in the Swa-Twam-Tat inquiry is always an ethical challenge to the self (Swa). Vulnerability is a basic tenet of Swa-Twam-Tat inquiry that connects the heart and soul of the self (Swa) and others (Twam and Tat). Next, I do not hold any pro-axiological assumptions that influence the formulation of research questions or the interpretation of field text, narratives, voices, and reflective notes. This inquiry is entirely my own, strictly adhering to the values and ethical considerations underpinning the research process. Ultimately, human relations are inherently ethical, giving rise to the idea that others may be harmed as much as their self (Roth, 2009). These ethical issues were addressed in my inquiry by engaging in critical self-reflective practices, thereby offering my research participants and a critical friend, and addressing the readers with the opportunity to revisit my genres of writing that aligned with relevant literature (Ellis, 1995). Further, the ethic of care, community transformation, responsibility, and compassion are other ethical considerations in my research (Luitel, 2009; Shrestha, 2018) that I have adhered to in my inquiry. The academic norms and values of the research participants, institutions, and community were highly admired and acknowledged, and their identities were not disclosed.

Likewise, ethical considerations in the Gyāna Parnāli within the Swa-Twam-Tat inquiry are important, as these Parnāli guide me towards a harmonious and respectful exploration of self (Swa) and the universe (Twam and Tat). This philosophical framework emphasizes the interconnectedness of the individual (Swa), the other (Twam), and the ultimate reality (Tat). Researchers like me must approach this inquiry with integrity, ensuring Twam and Tat's quest for knowledge does not harm others or themselves. Respect for diverse perspectives and experiences is crucial, as is commitment to truth and non-violence. Thus, adhering to these ethical principles can navigate Swa and Twam-Tat spiritual journey with compassion and wisdom, fostering a deeper understanding of the unity that underlies all existence. Finally, I also abided by all the ethical concerns outlined in the ethical guidelines from the KUSOED.

PHASE II
PORTRAYING MY SWA-TWAM-TAT INQUIRY

While reporting my Swa-Twam-Tat inquiry within the Gyāna Pranāli design space of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda, phase 2 offered my space (i.e., Swa as individual self) and my research participants and a critical friend space (i.e., Twam as relational selves) and the readers' space (i.e., Tat as universal self).

Considering the Swa-Twam-Tat inquiry, chapter 4 presents the "Mathematical Curriculum Spaces: Synergy of Local and Global Knowledge for Producing Innovators" guided by the emerging research question—how have mathematical curricular spaces been developed via the synergy of localization and globalization (i.e., glocalization) for producing innovative citizens? I subscribed to Ākhyāna writing as the process of inquiry to uncover my values, beliefs, and practices and writing narratives of my life worlds of self and others based on four research participants, critical friends, and field text, narratives, voices, and reflective notes between Master's degree and then MPhil degree, and PhD (2020-2023) rooted on transformative learning models—informing, reforming and transforming (Mezirow, 1991), curriculum images and metaphors (Schubert, 1986), knowledge constitute interests (Habermas, 1972), critical pedagogy—status quo, sensitization, and conscientization (Freire, 1970) and Swaraj perspective (Gandhi, 1909).

Chapter 5 presents the "Exploring School-community Relationships and Their Roles in Engaged Pedagogical Practices in Mathematics" guided by the emerging research question—how are engaged pedagogical processes practiced and envisioned in the school mathematics classroom? I used Ākhyāna writing as the process of inquiry connecting roles as a community facilitator of mathematics based on four research participants, the critical friend, and field text, narratives, voices, and reflective notes between MPhil and the first three years of my PhD engagements (2020-2024). This chapter is grounded in transformative learning theory (Mezirow, 1991), critical pedagogy (Freire, 1970), knowledge constitutive interests (Habermas, 1972), curriculum images and metaphors (Schubert, 1986), and Swaraj perspective (Gandhi, 1909).

Chapter 6 presents the “Teachers’ Professional Development Initiatives Around School Mathematics” guided by the emerging research question—in what ways have change-driven teacher professional development initiatives around school mathematics been inclusive to both local and global perspectives? I reported aligned to conscious, reflective writing, dialectical personal stories, metaphorical logic, and poetic expressions based on four research participants, the critical friend, and between a master’s degree, then an MPhil degree, and a PhD (2011-2023). This chapter is rooted in transformative learning theory (Mezirow, 1991), knowledge constitutes interests (Habermas, 1972), critical pedagogy (Freire, 1970), thr Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019).

Chapter 7 explores the “School Mathematics Teachers' Leadership Development Processes as a Reflective Teacher Leader” guided by the emerging research question: How has the leadership development process (teacher as a change agent and reflective teacher leader) been in place in areas of school mathematics education? I reported by exploring conscious, reflective writing, dialectical personal stories, metaphorical logic, poetic expressions, and visual representations based on four research participants, a critical friend inviting the readers, and the field text, narratives, voices, and reflective notes between MPhil degree and PhD engagements (2011-2023). This chapter is rooted in transformative learning theory (Mezirow, 1991), knowledge constitutes interests (Habermas, 1972), critical pedagogy (Freire, 1970), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019).

CHAPTER IV
MATHEMATICAL CURRICULUM SPACES: SYNERGY OF LOCAL AND GLOBAL KNOWLEDGE FOR PRODUCING INNOVATORS

In this chapter, I draw upon my experiences as a student, teacher, teacher educator, and STEAM scholar to examine the curriculum spaces within mathematics. To broaden my understanding, I enlisted the help of my research participants and a critical friend (e.g., Twam), inviting the readers (e.g., Tat) to provide cultural context and assist me in exploring the existing mathematical curriculum spaces in school mathematics. As I am penning down this chapter, I realize that mathematical concepts, topics, and skills imparted in mathematics education form an integral part of existing curriculum spaces. Undeniably, the mathematical content that students are expected to learn, which is a blend of local and global knowledge, resides within these spaces. In my Swa-Twam-Tat inquiry, I discovered that the curriculum space includes mathematical content, teaching methods, and assessment for students. Its goal is to provide learners with essential skills by integrating local and global knowledge systems, thereby fostering innovation and creativity in mathematics. With the above, this chapter addresses the emerging research question: How have mathematical curricular spaces been developed via the synergy of localization and globalization (i.e., glocalization) for producing innovative citizens?

This chapter is grounded on Schubert's curriculum images and metaphors (Schubert, 1986), and the transformative learning theory (Mezirow, 1991), considering the transformative model focuses on informing, reforming, and transforming models akin to technical, practical, and emancipatory curriculum interests (Habermas, 1972), and Freire's three stages - status quo, sensitization, and conscientization of critical pedagogy (Freire, 1970) and Swaraj perspective for developing imposed, shared, and autonomous models (Gandhi, 1909) for addressing dilemma and contradictions via post/formal thinking for community ownership. So, I strive to rethink the mathematics curriculum for addressing dilemmas and contradictions via post/formal thinking for community ownership to make it more student-centered, relevant, and engaging. This chapter is an outcome of considering different dimensions of mathematics, such as contextual learning, problem-solving, and technological learning, emphasizing the synergy of local and global knowledge in producing innovators.

Mathematics Curriculum Spaces for Pedagogical Change

It might be any Monday in June 2021; I approached a school in the Kathmandu Valley, Nepal, to facilitate a session for secondary-level mathematics teachers on the curriculum development process. After reaching the school and receiving a welcome from the principal, with all the preparation, I entered the session hall. The principal again greeted me, and all the teachers extended their best wishes. In response, I greeted them with a good morning. Following some logistical preparations in the room, the session began with a welcome address from the principal. After the principal's greeting, the principal handed me the platform. The discussion started with the question, "What is the curriculum?" Why is a curriculum necessary to facilitate the teaching and learning process? Why should mathematics educators be aware of how the curriculum develops? Do you have any experience designing a curriculum? To my surprise, most of the participants' responses differed from my expectations. I was taken aback by the teachers' reactions, and I took a short break from the session because my mind was filled with many questions.

(Personal Diary, June 2021)

The above experience is just one event, but this also seems to be the same for other schoolteachers. However, the curriculum serves as a roadmap for teachers and students, outlining the course of study, learning goals, teaching methods, and assessment techniques. It ensures that teaching and learning processes are structured, goal-oriented, and effective. Though the teachers at that school do not know much about the curriculum, they know the textbook, which represents the image of curriculum as a subject matter. Even for promoting instructional change, students' mathematical thinking, and community-based engagement, the curriculum is the minimal guideline (Land et al., 2019). However, Schubert's (1986) curriculum images, namely, curriculum as content or subject matter, curriculum as experience, curriculum as currere, curriculum as an agenda for social reconstruction, curriculum as a program of planned activities, curriculum as intended learning outcomes, curriculum as cultural reproduction, and curriculum as a process are helpful perspectives to understand the nuances of mathematical curriculum spaces.

Curriculum as content or subject matter views education as a structured body of knowledge, emphasizing the transmission of facts, concepts, and theories through traditional academic disciplines like mathematics, science, and literature. In contrast, curriculum as experience, inspired by John Dewey, focuses on the learner's active engagement and personal growth through meaningful, real-world interactions. Curriculum as currere, developed by William Pinar, takes a deeply personal approach, encouraging autobiographical reflection to explore how past, present, and future educational experiences shape one's identity and aspirations. Meanwhile, curriculum as an agenda for social reconstruction positions education as a transformative tool for addressing social injustices, promoting equity, and empowering learners to become agents of change. Curriculum, as a program of planned activities, emphasizes systematically organizing instructional strategies, lesson plans, and assessments to achieve specific educational goals.
Similarly, curriculum as intended learning outcomes focuses on clearly defined, measurable objectives that guide teaching and assessment, ensuring alignment between what is taught and what students are expected to learn. From a critical perspective, curriculum as cultural reproduction examines how education can reinforce dominant cultural norms and social hierarchies, advocating for inclusive curricula that reflect diverse voices and experiences. Finally, curriculum as a process highlights the dynamic, interactive nature of teaching and learning, where knowledge is co-constructed through dialogue, inquiry, and reflection rather than passively received. Thus, Schubert’s (1986) curriculum images and metaphors—including *Curriculum as Content or Subject Matter*, *Curriculum as Experience*, *Curriculum as Currere*, and *Curriculum as Social Reconstruction*, alongside frameworks like *Curriculum as a Program of Planned Activities*, *Curriculum as Intended Learning Outcomes*, and *Curriculum as Cultural Reproduction*—serve as lenses to critically examine the curriculum through diverse perspectives. So, mathematics educators must be aware of the curriculum development process aligned with Schubert's (1986) curriculum images because it allows them to understand the rationale behind the chosen topics, the sequence of topics, and the depth of content required at each grade level for their instructional plan. This understanding can enhance their teaching strategies, making them more effective in imparting knowledge and skills to their students.

For instance, Hari, one of my research participants, revealed that his teaching initially and persistently aligned with the *Curriculum as Content*, driven by institutional constraints, though he acknowledged its limitations. To counterbalance this, he experimented with *Curriculum as Experience* by integrating performing arts (poems, metaphors, cartoons) and project-based learning in mathematics, aiming to ‘explore the hidden talents of students.’ Similarly, despite technological shifts, Santosh critiqued the stagnation of curriculum and pedagogy, emphasizing his efforts to blend *Curriculum as Intended Learning Outcomes* (developing knowledge and skills) with the curriculum as a process (adaptive teaching strategies) to foster students’ mathematical problem-solving competencies. Kamal’s critique of outdated curricula and his call for reimagining *how* mathematics is taught resonates with tensions between *Curriculum as Cultural Reproduction* (static traditions) and *Curriculum as Social Reconstruction* (glocal innovation via citizenship education). His question—‘how do we blend global and local practices?’—highlights the need for curricular space that transcends rote content delivery. Aarati, meanwhile, echoed this complexity, noting that efforts to ‘blend glocal curriculum’ remain abstract for many teachers. Her attempts to engage learners by aligning with their interests and identities reflect *Curriculum as Currere* (personalized journeys of students and teachers) and *Curriculum as Social Reconstruction* (equity-driven design), yet she admitted uncertainty about implementation: I don’t know how or when.’ These narratives illustrate how Schubert’s metaphors expose gaps between curricular intent and practice while also offering pathways for rethinking mathematics education in dynamic, inclusive ways.

Reflecting on my journey, I realized that my early curriculum development work at the university level heavily prioritized *curriculum as content*, often neglecting other lenses, particularly in school contexts where awareness of these metaphors remained limited. During my MPhil coursework in 2015, I encountered the concept of 'curriculum spaces,' which was inspired by Schubert's emphasis on the interplay of physical, social, and cultural dimensions of learning. I understood curriculum spaces as dynamic environments where local and global knowledge intersected notions echoed by my research participants, who advocated for blending local epistemologies into mathematical learning. These spaces excel classrooms to include schools, communities, and the wider world, shaping how students engage with mathematics. For instance, *mathematical curriculum spaces* (Lee et al., 2020) emphasize connecting learners' lived experiences and cultural knowledge to broader mathematical concepts, aligning with Schubert's contrasting images of *Curriculum as Cultural Reproduction* and *Curriculum as Social Reconstruction*. This approach acknowledges students' diverse knowledge bases (Land et al., 2019) and positions teachers as facilitators who bridge these "multiple mathematical worlds." When curriculum spaces are intentionally designed—drawing on frameworks like *Curriculum as Experience* (student-centered inquiry) and *Curriculum as Process* (adaptive pedagogy)—students deepen their mathematical understanding and see their identities and contexts reflected in the curriculum. This fosters investment in learning as abstract concepts become meaningful through local and global connections, critical dialogue, and socially relevant applications.

All the above mathematical curriculum spaces—curriculum as content or subject matter, curriculum as experience, curriculum as currere, and curriculum as social reconstruction, alongside images like curriculum as a program of planned activities, curriculum as intended learning outcomes, and curriculum as cultural reproduction allow students to explore mathematical concepts more engaging and hands-on, leading to authentic learning and understanding to be the innovator and serve as lenses to critically examine the curriculum through different perspectives in a variety of ways. I find Land (2019) uses graph and order theories to inform curriculum design, aiming to create a space for interconnected curriculum images. Graph theory helps map relationships between different concepts, while order theory aids in sequencing topics for optimal learning progression maybe through curriculum as subject matter, curriculum as experience, and curriculum as planned activities. Land measuring work in mensuration topics specifically focuses on integrating children’s mathematical knowledge into the curriculum, ensuring that new content builds on what students already understand and experience, making learning more coherent and effective. Next, Drake et al. (2015) propose methods for expanding these spaces, offering tangible tools for curriculum development. Opposingly, D’Aambrosio (2016) highlights the cultural and interdisciplinary sides of curriculum spaces—planned activities and cultural reconstruction specifically addressing the application of learning spaces in educational technology. These educational technologies integrate the use of digital tools and resources to enhance the teaching and learning of mathematics. This includes interactive software, online platforms, virtual manipulatives, and adaptive learning systems that provide personalized feedback, which is likely to promote dialogues across the system by bringing the image of curriculum as an experience to play.

Learning Mathematics as Experience: Exploring Mathematics Classrooms

Ethnomathematics may align with Schubert's (1986) curriculum images of curriculum as experience and reconstruction as the notion of ethnomathematics arises from students' cultural experiences with a desire to reconstruct mathematical knowledge systems. For me, these images emphasize the importance of learners' lived experiences in shaping educational processes wherein ethnomathematics, by design, integrates students' cultural contexts, practices, and real-world applications into mathematics education, making learning more meaningful and relevant. As I arrive at this stage, I realize that curriculum as experience and reconstruction help to challenge the traditional image of curriculum as subject matter (which prioritizes static, universal knowledge transmission) by instead valuing how cultural experiences influence the understanding and learning of mathematical concepts. While there may be secondary connections to the metaphor of curriculum as currere (focused on lifelong learning and personal development), the primary alignment lies with "experience," as ethnomathematics actively centers students' cultural identities and daily realities as foundational to curriculum design as I connected mathematical ideas of parallel lines with the opposite edges of the windows at my home in the village.

However, school mathematics at my time was and is still considered abstract and utterly irrelevant in connecting to daily life (e.g., Dahal, 2013, 2017). So, the critique that school mathematics in Nepal is perceived as abstract and disconnected from daily life (Dahal, 2013; 2017) aligns most strongly with the curriculum as content or subject matter and curriculum as discrete tasks and concepts in Schubert's (1986) curriculum images. The major criticism is that different curriculum images and textbooks are not aligned as textbook-based teaching was very much aligned with content transmission. Students treat school mathematics in general and the university mathematics image of curriculum as discrete tasks and concepts (a collection of formulas and calculations) unrelated to our daily lives or even the real world. The mathematics curriculum, pedagogy, and assessment are one-size-fits-all designs. The role of mathematics teachers is to transfer mathematical knowledge from the teacher's head to students' minds. Realizing the need for trans/formation in curriculum, pedagogy, and assessment in mathematics, I attempted to bring mathematics into the context of the learners' everyday experiences.

It could be any Sunday in February 2020; I was on a mission to incorporate an innovative approach into the mathematics curriculum, as the day was the first day of the statistics lesson. With regular planning in the school chamber, I went to the class of grade IX. Students greeted me with a loud voice—Good Morning, Sir! I also greeted them in response–Good Morning, everybody! After the settlement of each of the learners, I oriented them about the class proceeding and asked, "What are you going to learn in today's class?" Also, I added that I want to use something different ways to teach mathematics today. Further, I told them that I decided to bring mathematics into the context of their everyday experiences. As the class continued, I introduced some real-life problems in developing the budget for a picnic. For developing the budget, I created an interactive method for teaching budgeting in a mathematics class by assigning students a practical project: budgeting for a picnic because the school's picnic for all the students was approaching. The students were divided into six groups, each with four students, and tasked with developing their own budgets. The project required them to research potential picnic locations, investigate the variety of services provided, and assess the associated costs. Once I offered instructions, the students diligently constructed their budget plans, detailing every expense and including various recreational activities. I was impressed by their commitment and the initiative of their budgetary proposals. While reflecting, I realized that the completion of this project enabled the students to acquire a thorough understanding of budgeting concepts. In addition, students realized multiple benefits from the group work. They learned valuable skills such as researching picnic locations, identifying and categorizing expenses, and creating a detailed budget. In addition, they learned to make thoughtful suggestions for selecting the ideal picnic location. This project proved to be an exceptional way for students to comprehend budgeting in a real-world context, enhancing their research, analytical, and problem-solving skills.

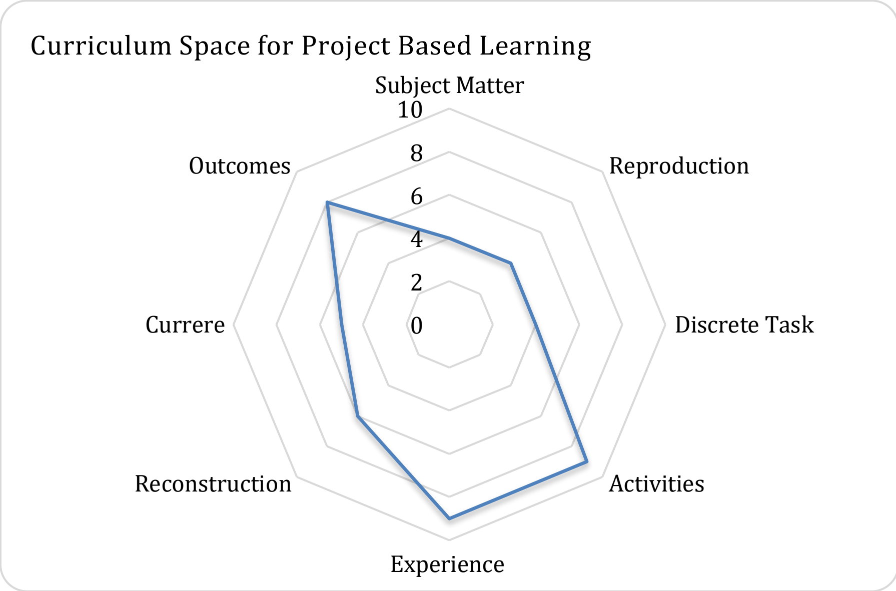
(Personal Diary, March 2020)

Atteh (2021) and Benson-O'Connor (2019) advocated for problem-solving and real-life applications that may be part of the curriculum as lived experience, learning outcomes, and reconstruction. The budgeting task has triggered grade IX learners' curiosity about selecting the items and the number of items to be included in the budget. As a mathematics teacher, I offered the students the idea of developing a budget that interested each of them. It was a pleasant movement as all the students had different budget plans. To further enhance the relevance of budgeting, I encouraged students to explore different types of items in the budget plan for the picnic. Brady et al. (2015) emphasize the importance of incorporating real-world problems (may connect with the curriculum as lived experience), such as climate and environmental crises (may connect with the curriculum as reconstruction), and preserving diversity and mathematical modeling (may connect with the curriculum as reconstruction) in teaching. Through this project, the students developed problem-solving skills, critical thinking abilities, and an appreciation for the power of mathematics in decision-making. Problem-solving focuses on students demonstrating (may connect with the curriculum as learning outcomes) efficiently identifying, analyzing, and resolving issues systematically by evaluating information 'objectively' as a key aspect of critical thinking. By applying critical thinking, learners can make well-informed decisions. Additionally, mathematics plays a crucial role in decision-making by providing a logical framework for analyzing field text, narratives, voices, and reflective notes and making precise, informed choices.

Next, my research participants generally reacted that this is a doable project, but the classroom size and availability of resources are limited. However, a critical friend added, 'This could be an innovative teaching approach, but it must be implemented well.' Reflecting on the nature of the Project, my idea of innovation is reflected in the dimensions of world-word connection, serving the interests of the learner, embodying the complexity of everyday life, and bringing community contexts to the fore, as reflected in the boxed text. For instance, Bishop (2007) added that there is a need for students to see the value and relevance of mathematics, whereas Nicol (1999) suggested that imaginative tasks can engage students, who can participate in the discourse of the relevance of mathematics, reflecting the use of emancipatory interests. I emphasized learning from mistakes to foster a growth mindset and encourage perseverance via communicative and practical

> Freire poses- *Do your Projects project the world onto the texts?*
> ***
> Habermas asks– Who is being projected in your projects?
> ***
> Mezirow- *Do you project complex everyday life problems in your Projects?*
> ****
> *Gandhi – Do you import Projects or project them as problems of your own community?*

pedagogical approaches. These activities might have addressed the skepticism and disinterest in mathematics that had given way to enthusiasm, curiosity, and a newfound appreciation for the subject.



During the sharing session of the budget plans, students thanked me for my dedication and innovation. I had led them. As I reflect on this process, my curriculum space based on project-based learning would have given more emphasis on curriculum as experience, activities, learning outcomes, and some degree of pedagogical reconstruction through participatory activities, as portrayed in the adjoining figure.

Designing a Mathematics Unit Around Interest

To generate pedagogical thoughtfulness among the readers (i.e., Tat), I have envisioned the dialogue between me (Niroj) and Naresh (a critical friend) on "Designing a Mathematics Unit Around Interest". The dialogue may have gone as follows:

Niroj: Hi Naresh, I have been considering designing a new mathematics unit for my students of grade IX. I want to make it interesting and engaging. Do you have any ideas?

Naresh: That sounds like a great initiative, Niroj! Let's start by identifying the areas of mathematics that our students find most interesting.

Niroj: That is a good point. From my observations, they enjoy problem-solving activities, especially when they can relate them to real-world scenarios.

Naresh: Excellent! We could design the unit around practical applications of mathematics then. For instance, we could include topics like budgeting, calculating height and distances, and areas of their classroom.

Niroj: I love that idea! It would make the content more relatable for the students. Plus, it would help them understand the importance of mathematics in everyday life.

Naresh: Exactly! We could incorporate various teaching methods to ensure we furnish different learning styles. For example, we could use interactive activities, group projects, and digital tools for some lessons.

Niroj: That's a comprehensive approach, Naresh! I think this could enhance our students' learning experience and interest in mathematics. Let's start working on this!

(Personal Diary, March 2021)

Wininger et al. (2014) emphasize the importance of cultivating and assessing students' interests in mathematics learning. So, the dialogue between me (i.e., Niroj) and Naresh may provide insight into designing a mathematics unit that is potentially engaging and relevant to students. Naresh and I seemingly prioritize the interests and needs of our students in the design process. For instance, Huang et al. (2020) propose student-centered activities, such as interest-driven video creation and other text tasks, to enhance interest and engagement. We (Naresh and I) appear to identify areas of mathematics that students find most interesting, suggesting a student-centered approach to curriculum design as a collaborative venture that aligns closely with the curriculum as experience and curriculum as currere as per Schubert (1986). However, it also sounds like Habermas's practical interest-driven curriculum is a process that challenges narrower lenses, such as *curriculum as content* or *discrete tasks and concepts* (Grundy, 1987). Wolfmeyer (2023) commented that "mathematics teachers thoughtfully consider every classroom lesson as a social experience from which each student makes meaning for mathematical content." (p. 19). Likewise, the dialogue emphasizes the importance of relating mathematical concepts to real-world scenarios. Lamberg and Moss (2023) further explore the role of value construction and the affective, cognitive, and value components of interest in mathematics learning. This includes practical applications such as budgeting, calculating distances and areas, and analyzing sports statistics. Likewise, Naresh and I discussed the need to offer different learning styles by incorporating various teaching methods. This includes interactive activities and group projects. Next, our conversation aims to enhance students' learning experience and foster their interest in mathematics.

Creating Mathematics Problem Scenarios

It could be any day in July 2018, as a mathematics teacher at the secondary level, that I got the chance to facilitate the development of the Rangoli for the grade X students in Tihar. In school, I was known for my passion and creativity in teaching mathematics to students, integrating different concepts and ideas of other subjects, social and cultural issues, and festivals that have rich cultures and traditions. I believed the best way to make mathematics enjoyable was by creating problem scenarios that resonated with school culture. So, on the same day, I entered the classroom of grade X to introduce the students to an exciting new task that directly aligned with integrating mathematical concepts. I looked at the students' eager faces to find a way to ignite their curiosity. With their curiosity, I shared an inspired story about the Rangoli that aligned with the rich culture and traditions. So, I also assigned all the students to develop the Rangoli using colorful powders from the school store. However, I realized that students also realized that they were running out of time and needed help to figure out how much color powder they would need to complete the design as uniquly as possible. The students were intrigued and could not wait to develop the Rangoli. The students promptly commenced brainstorming ideas, deliberating on diverse methodologies, and collaborating to enhance the design for the Rangoli. I urged them to develop critical thinking skills and assisted them when facing challenges. In another lesson, I demonstrated various patterns and urged the students to design their own Rangoli at home, highlighting the significance of intricate designs. I also recommended that they arrange their Rangoli development schedule. The students fervently articulated their ideas, deliberating various strategies and justifying their methodologies. Observing their fervor and competitiveness was inspiring, as they concentrated on employing mathematics to develop a project that embodied their cultural celebrations. As an outcome, with different levels of engagement, students developed the Rangoli on school grounds and were ready to develop the same in their houses.

(Personal Diary, July 2018)

I was to create problem scenarios from our cultural perspective, allowing my students to see mathematics as more than numbers and formulas. It might have helped them understand their identity, culture, and traditions, and realize mathematics was everywhere. I challenged my students with culturally inspired math problems throughout the year. Each problem, whether measuring spices for a traditional dish or calculating the cost of materials for school crafts, gave my students pride in their heritage and a deeper understanding of mathematics. My teaching methods still resonated with the school community when I visited in October 2023. Different math teachers realized that math was a tool to explore their cultural roots and began incorporating different cultural perspectives into their lessons. I received thanks from all the schoolteachers and principals for creating math problem scenarios that reflected our cultural perspectives. I realized that schoolteachers could carry their knowledge and pride, inspiring future generations to embrace mathematics and their rich cultural heritage. They need to be aware of potential deception that might occur in the collective.

Communities unite, voices in sync,
But deception might be possible
Participation broadens from each link,
Questioning the intent is also necessary
Together, we flourish, diverse and strong,
But whose interests are being served is the key
Involving all, where belonging belongs,
And, belonging might also be hegemonic

(Personal Diary, October 2023)

Sealey and Noyes (2010) highlighted the need for a relevant curriculum, pedagogy, and assessment, particularly in the context of school-community partnerships. In this distinctive role of a secondary-level mathematics teacher, I was given the unique opportunity to design a Rangoli[16] for the Tihar festival with multiple sensibilities, as I presented in the adjoining box. I was convinced that creating problem scenarios reflecting the

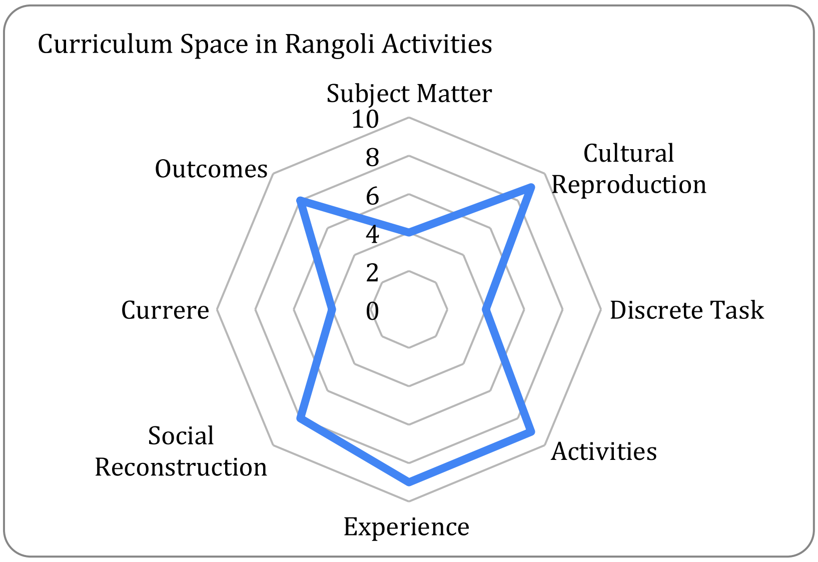
> Rangoli as word and World in colors
> Freire lives in each shape
> ***
> Rangoli as women power
> Empowering for gendered voices
> Habermas peeping through lines
> ***
> Dilemma of local versus global
> Mathematics occurs as the meeting point
> Mezirow rocks in the glocal space
> ***
> Rangoli is our own creation
> We make it and revise it – Gandhi speaks

[16] The traditional Eastern decorations and patterns are made with ground rice, particularly during festivals.

school's culture would make math fun. Baroody and Hume (1991) and Fuson et al. (2015) emphasize developmentally right pedagogical approaches and the predictive power of early mathematical knowledge connecting to culture and math concepts. I walked into the tenth-grade classroom, excited to introduce the students to a potentially engaging task deeply rooted in mathematical concepts. I grabbed this chance to share a story about the Rangoli, a narratively deeply connected with our culture and traditions (largely in the southern plane and Madhesh Province of Nepal). From that moment, I assigned all the students the task of creating the Rangoli using colored powder. I encouraged them to think critically and provided guidance when they encountered challenges. Jones et al. (2009) and Bay-Williams et al. (2003) focus on the role of teacher knowledge and attitudes, with the former showing the potential for change through professional development and the latter discussing the implementation of standards-based curricula. Hence, I demonstrated various patterns to the students and suggested they create Rangoli to decorate their homes. My commitment to creating problem scenarios from our cultural perspective allowed students to see mathematics as more than just numbers and formulas. It helped them explore their identity, culture, and traditions. Schoenfeld (2002) addressed equity by incorporating reading strategies into math lessons and advocating for empoweringly, high-quality education for all students. I identified that my teaching methods appeared to have spread throughout the school community during a subsequent visit. Other math teachers seemingly realized that mathematics could be used to explore their cultural roots and began incorporating different cultural perspectives into their lessons.

For me, the Rangoli project for Tihar exemplifies the concept of curriculum as lived experience and reconstruction (Schubert, 1986), a progressive educational philosophy rooted in Deweyan principles and possibly Freirean-Habermasian critical-emancipatory perspectives. Firstly, the curriculum is dynamic and experiential. Traditional curricula often prioritize abstract, decontextualized knowledge. In contrast, the teacher transforms mathematics into a lived experience by anchoring it in the cultural practice of Rangoli-making. Students engage with mathematical concepts such as geometry, measurement, and symmetry through hands-on design, problem-solving (like calculating color powder quantities), and collaboration. This shifts the curriculum from static content to an active process of inquiry, mirroring Dewey’s belief that education is “a process of living, not a preparation for future living.”

Secondly, the students reconstruct their understanding of mathematics by applying it to a culturally meaningful task with a link to the Freirean idea of learning beyond the banking model. Thirdly, the curriculum integrates culture and social context rooted in students' lived realities by centering Tihar, a festival integral to their cultural identity, valuing cultural traditions as a vehicle for learning. The teacher bridges the gap between school and community, fostering relevance and emotional engagement. Fourthly, the teacher acts as a facilitator of experience as they guide students to develop critical thinking rather than dictating methods, probably aligning with the Habermasian idea of developing authentic insights. This empowers learners to take ownership of their learning process, a hallmark of curriculum as reconstruction and the Gandhian notion of reclaiming community heritage through learning. For example, allowing students to brainstorm designs and troubleshoot material shortages encourages autonomy and intellectual development. Fifthly, the collaborative nature of the project, where students deliberate strategies and justify methodologies, reflects Dewey's emphasis on social interaction as central to learning, as the classroom becomes a democratic space where knowledge is co-constructed through dialogue and real-world problem-solving. Lastly, the curriculum image embedded in Rangoli activities is likely to foster outcomes beyond content mastery, as shown in the adjoining figure. Students gain mathematical proficiency while developing creativity, time management (such as arranging their Rangoli development schedule), and cultural reproduction and reconstruction.



Connection to Local and Global (i.e., Glocal) Knowledge Systems in Mathematics

It could be any day in November 2020. I was planning my mathematics class for grade IX of arithmetic. So, I curated the following story for the class.

Once upon a time, there was a small village named Majuwa in Dolakha, Nepal. The Himalayan village is surrounded by brilliant scenery and grassy ground. Mr. Chetan is a mathematician teaching in the village. Mr. Chetan firmly thought that mathematics was a universal language that was able to link the local and worldwide knowledge systems, not only a topic limited to textbooks and classrooms.

He was quite aware of the need for close bridging between conventional methods and modern mathematical ideas. Having the above points of view, one morning in November 2020, Mr. Chetan observed his students bursting with enthusiasm as he walked into his classroom. They had heard he would introduce them to a special method of learning mathematics whereby their local knowledge systems would be linked to the mathematical universe worldwide. He started by relating a narrative about Nepal's customary land measurement system. He described how residents measured their agricultural fields using the historic "Ropani" system. The pupils listened carefully and saw that mathematical ideas were underlying this conventional approach. Mr. Chetan created a problem scenario to show the link between local and worldwide knowledge systems. He asked his students to calculate the area of a field using both the modern metric system and the traditional Ropani system. I hope that this exercise will help students see the practical application of both systems and appreciate the value of their rich cultural heritage as the classes went on the other days. Including local and global knowledge systems, Mr. Chetan guided his students in mathematical investigation. He presented concepts, including tessellations, which allowed one to examine the complex patterns in traditional Nepali pottery and their proportionality using historical temple design and construction. The innovative methods Mr. Chetan used helped his students to view mathematics as a field of study spanning more than just basic numerical concepts. It preserved the cultural legacy and clarified the surroundings. Their local knowledge systems included deeply rooted mathematical concepts that were just waiting for investigation and appreciation. Occasionally, Mr. Chetan was invited to a mathematics conference held in the capital, Kathmandu. This allowed him to demonstrate the success of his particular teaching strategies and the need to include local and global knowledge systems. Using locally made materials, Mr. Chetan *enthralled the conference attendees with gripping tales and images of his combining mathematical concepts with Nepal's cultural legacy. Using his experiences and applying related techniques in their classrooms attracted many Asian teachers and researchers. By sharing his journey and expertise, Mr. Chetan became a motivation for change in how mathematics was taught across the region. Mr. Chetan's efforts helped nurture a generation of students who excelled in mathematics and felt strongly connected to their cultural heritage.*

(Personal Diary, July 2021)

Complex and varied relationships exist between local and global knowledge systems. I refer to them here as two sides of the coin, for one gives rise to the other as the local of somewhere becomes global and vice versa. Bathelt and Cohendet (2014) emphasize the interdependence of these systems; as Mr. Chetana states in the narrative, local knowledge is essential for mathematical concepts, while international knowledge sourcing enriches local knowledge. Referring to the boxed text, Chetana's horizon of understanding could be extended beyond the seemingly romanticization of local by referring to multiple knowledge systems, establishing different knowledge systems through multiple logics, having ownership of mathematical knowledge systems, and creating opportunities for an authentic voice for students. No issues arise in this relationship. According to Le Roux and Swanson (2021), "critical scholarship on mathematics education within sociopolitical, global citizenship education, and decoloniality" is essential (p. 323). As expressed in poetic form in the adjoining boxed text, the dynamic interaction of knowledge types requires integrated and flexible knowledge management systems that combine local and global knowledge. Mauro and Hardison (2000) stress the importance of recognizing and preserving local knowledge, especially in Indigenous communities. Indigenous and other knowledge systems can share insights and benefits. To help 21st-century students develop, Adler and Lerman (2003)

> Freire: Are you raising the consciousness about different knowledge systems?
>
> Mezirow: Are you applying multiple logics to connect them?
>
> Gandhi: Are you establishing the relevance of mathematical knowledge?
>
> Habermas: Are you creating opportunities for students for the authentic voice?

provide a comprehensive context for discussions on the pragmatic, ethical, and epistemological aspects of global and local knowledge organization in mathematics.

Even the synergy of global and local knowledge in mathematical curriculum spaces is a risk-taking issue in our context, as CDC (2019), Nepal develops curricula with consulting with the teachers, scholars, and policymakers employing more than one curriculum images (subject matter, activities, and reconstruction to some extent). However, the implementation of different images inside the classroom is problematic (Personal Communication, Purushottam Ghimire, CDC Officer). Perhaps, there is a need for a critical and reflexive approach to mathematics teaching and learning (Roux, 2021), particularly in the context of glocal citizenship that prepares students for planet earth without losing their rootedness. Perhaps, the use of ethno-modeling to explore glocal mathematical knowledge systems (Rosa & Orey, 2021) is helpful. Thus, the way this connection impacts mathematics teaching knowledge is all about bringing together local cultures and global ideas in a friendly and meaningful way!

Trans/disciplinary Teaching across Mathematics

> *It could be any day in July 2018 when I was serving as a part-time mathematics teacher in one of the schools in Lalitpur. The school was known for its traditional approach to teaching mathematics. As per my engagements over the last two years, the students were active but often struggled to see the relevance of the mathematical concepts they were learning. The school sought a new and innovative teacher who could solve the issue in lower grades, such as grades VI, VII, and VIII. So, in one of the demo classes of Ms. Wi-Fi in Grade VI as she was short-listed for an interview, the principal called me to be part of it. In the interview with Ms. Wi-Fi, she introduced several strategies to support this approach to overcome the issue. Firstly, she introduced real-world projects that required students to apply mathematical concepts to solve real-world problems. For example, students had to design a garden using their knowledge of area and perimeter or plan a budget for a school event using their understanding of percentages and ratios. Secondly, she shared the power of collaboration with other subject teachers while designing interdisciplinary lessons. She shared that students used statistics to analyze climate data in a joint lesson with the geography teacher. In collaboration with the Art teacher, students learned about the role of geometry in design. Thirdly, she shared the use of technology in teaching mathematics in her*

lessons. Students used computer software to visualize mathematical concepts and online project collaboration platforms. And finally, she shared the importance of reflections and discussion. She emphasized encouraging students to reflect on their learning and discuss how they applied mathematical concepts in each project. Eventually, a new teacher, Ms. Wi-Fi, was appointed for the new academic year. She believed in transdisciplinary teaching, which integrated mathematical concepts with real-world applications across various disciplines.

From the above narrative, it is reflected that "transdisciplinary framework allows for a multifocal exploration of classroom talk practices" in mathematics (Robertson & Graven, 2018, p. 1013), and the impact of trans/disciplinary (here the slash represents the dialectical interplay between disciplinary and beyond!) teaching strategies has been useful for integrated ways of teaching and learning mathematics in Nepal. Kuwar and Acharya (2024) discuss the benefits of integrating different subjects that help students see the relevance of mathematics in different contexts.

As I reflect on the process of using trans/disciplinary pedagogy, my students began to see mathematics as a subject and a tool to understand and navigate the world. They were engaged in their lessons, improving their performance significantly. However, the Secondary Education Examination (SEE) result did not demonstrate it as the assessment model embedded in SEE would only focus on curriculum as subject matter and discrete tasks and concepts.

Despite the narrowly conceived notion of assessment widespread in Nepal, the story of Ms. Wi-Fi and her future students shows us the power of trans/disciplinary teaching in mathematics as it could integrate curriculum as activities, experiences, and reconstruction with curriculum as subject matter and cultural reproduction, connecting mathematical concepts to real-world applications can make learning more meaningful and engaging for our students. Papadakis et al. (2021) emphasize the need for variation while teaching by integrating real-world concepts to enhance student engagement in

> Gandhi: Communities do not see their problems in silos, rather they see those as whole and complex.
>
> Mezirow: Disciplines are means for addressing dilemma situation; they not the ends in themselves.
>
> Freire: Disciplines can be limiting for helping learners to become conscious problem solvers.
>
> Habermas: Critical voices can disappear in the borders of disciplinary egoism.

mathematics in indoor and outdoor activities. Such an approach to teaching may be needed to solve complex problems and improve math education, as represented by differing voices of perspectives in the adjoining box.

Magidson (2005) examined the challenges and rewards of building bridges between mathematics communities and stressed the importance of trans/disciplinary teaching in mathematics for relevance, complex problem-solving, and collaboration.

Thus, trans/disciplinary teaching integrates multiple disciplines and is useful for addressing complex glocal issues, such as climate change, public health crises, technological ethics, and social inequality. It motivates long-term and creative use of memory. This requires critically examining disciplinary boundaries and developing transdisciplinary thinking skills in school and higher education (Dahal, 2022b; Daneshpour & Kwegyir-Afful, 2022). Mathematics teachers from different backgrounds also dispute designs in transdisciplinary design. Despite these obstacles, trans/disciplinarity can solve complex social issues and shed light on open social systems (Jerome et al., 2024). Last, Ms. Wi-Fi's trans/disciplinary curriculum activities for her future students can change teachers' educational beliefs and promote multiple perspectives for mathematics teaching and learning innovation.

Swa Inquiry: First-Person Reflections

My inquiry focuses on my personal experiences and reflections that contribute to developing a vision for STEAM-based mathematics education. Probably taking the image of curriculum as currere, my Swa inquiry is not just an egoist self but to unpack its multiple dimensions as mentioned in the boxed texts. I am dissatisfied with educators' inadequate understanding of curriculum design, as demonstrated in the June 2021 session, which reinforces my belief that the curriculum should serve as a framework for organized, objective-driven learning. I was surprised by educators' substantial reliance on textbooks, which highlights a significant gap between policy and implementation, emphasizing the need for teachers to have a deeper understanding of curriculum development. Through my personal projects, such as the budgeting project in March 2020 and the Rangoli design in July 2018, I try

> Habermas: Did I give opportunities to my ego to turn into itself?
>
> Gandhi: Did I ask my inner self (i.e. Antar Atma) about my humility?
>
> Mezirow: Did I investigate my dilemmatic self and try resolving it?
>
> Freire: Did I become conscious enough not to reproduce the oppressed texts?

to demonstrate connecting abstract mathematical concepts with applications. These initiatives reflect on my involvement in culturally responsive and student-centered education that promotes citizenship, allowing students to engage with mathematics in meaningful and relevant ways. I also recognize my limited experience in school-level curriculum design and am intrigued by the concept of "curriculum spaces," which I encountered during my doctoral studies as a composite image of curriculum based on Schubert's eight different yet interconnected images. This space has been helpful in integrating localism and globalism as a resource to the deficient mindset embedded in 'inferior local' and 'superior global.' Trans/disciplinary teaching, exemplified by Ms. Wi-Fi's narrative, aligned with my reflections, indicates my openness to collaborative, interdisciplinary strategies, highlighting my development as an educator dedicated to innovative and inclusive mathematics education.

Twam Inquiry: Second-Person Relational Reflections

The inquiry examines collaboration and community orientation by focusing on interactions with my participants, which I address as you, showing I-thou relations in any inquiry. Systemic challenges, including antiquated curricula (i.e., curriculum not as 'contents' but as a living tapestry through dialogues), rote pedagogy, and resource limitations, are elucidated through discussions with educators such as Hari, Santosh, and Kamal. Their critiques and skepticism expose institutional inertia, exemplified by the remark that "pedagogy has not evolved from chalk to smartboard" as subject matter, "nor has it fully realized the potential for dialogic contexts". In contrast, their endeavors, including the incorporation of arts and project-based work, indicate the possibility for grassroots transformation, considering curriculum as a shared journey rather than a prescribed path. The budgeting and Rangoli projects illustrate the relational dynamics among students, featuring how their enthusiasm for culturally pertinent activities, such as estimating picnic budgets or crafting festival art, cultivates a sense of ownership and engagement by giving room for dynamic curriculum spaces informed by curriculum images beyond curriculum as subject matter. The importance of social

> Gandhi: I exist because of *you* and them!
>
> Habermas: *Your* existence is authenticated by *your* ability to challenge the self and the structure.
>
> Freire: *You* should be in the process of becoming a consenscientized teacher.
>
> Mezirow: *Your* dilemmas are resolved through your consciously developed frame of reference.

learning and collaboration is highlighted by group work and peer discussions, exemplified by examining strategies for the Rangoli design and its potential to exemplify curriculum as experience, among others. Moreover, the dialogue with Naresh in March 2021 demonstrates the collaborative development of curriculum units. Our focus on student interests, encompassing real-world applications and varied learning styles, highlights the significance of teacher collaborations in redefining pedagogy. These interactions collectively demonstrate the capacity of cooperation to enhance mathematics education, making it more engaging, meaningful, and inclusive.

Thus, the above discussion helps Twam to see the systemic challenges of using Schubert's (1986) curriculum metaphors. The old, rigid "curriculum-as-plan" clashes with the dynamic "curriculum-as-lived." However, Twam collaborators' hands-on experiments, like project-based learning and peer mentorship, show a new way: curriculum as a conversation. Even though institutional barriers remain, they start to break down, moving from outdated chalkboard methods to modern, interactive smartboard approaches. So, this inquiry maps a relational ecology where mathematics education is explored through the exchange of critique and creativity. Thus, reflection in second-person reflections underlines that curriculum is not only what but also how, why, and who: a dynamic, inclusive process shaped by the voices you hold space for.

Tat Inquiry: Third Person 'Universal' Insights

Tat inquiry integrates my work into the conversation on mathematics education by establishing a link between their relational and personal experiences and more theoretical and conceptual orientations of potential universalism as represented by the Other. So, my Tat inquiry attempts to establish a connection between my personal and relational experiences and broader theoretical and conceptual perspectives, thereby integrating my work into the so-called global discourse on mathematics education. The concept of curriculum spaces, as defined by Drake et al. (2015) and Land et al. (2019), conceptualizes curriculum design as a structured yet adaptable process, underscoring the significance of establishing an adaptive and interconnected educational landscape, which I connected with the pre-existing,

Gandhi: All is within including others. Freire: The Other is connected through critical dialogue. Habermas: The Other is gauzed through an authentic insight. Mezirow: The Other is a source of context for shared experience.

somewhat universal idea of curriculum images. The Rangoli project of the researcher is a practical illustration of this approach, which is consistent with the principles of ethno-modeling (Rosa & Orey, 2021), potentially guided by the curriculum as reconstruction and experience. Mathematical concepts, such as proportionality and tessellations, combine global approaches with local traditions, such as the Ropani measurement system. This mix of local and global knowledge shows how we can create learning environments that support a broad understanding of math while respecting cultural traditions, offering a way to teach that is sensitive to different cultures.

The example of Ms. Wi-Fi’s lesson design, which includes math, geography, art and technology, represents the theme of transdisciplinary learning. This method of instruction aligns with global goals for issues-based study (Bishop, 2007; Nicol, 1999), pointing out that the role of mathematics is to solve practical problems. It also follows Magidson's (2005) argument against psychological disciplines. Wi-Fi's methods show how transdisciplinary education can produce more relevant and engaging learning environments for students, given that she transforms math into lessons that are connected to a number of other disciplines. Moreover, these lessons endow the students with the problem-solving abilities needed to tackle complex, integrated problems. This case study highlights the potential of more transdisciplinary approaches to reshaping traditional maths pedagogy into dynamic and problem-solving-oriented teaching. In common with the socio-political critique by Le Roux and Swanson (2021) of what constitutes mathematics education, the idea may parallel qualities of an educational system present in different thinkers. These could connect with the multiple dimensions of Freire’s anti-banking orientation cycle, the role of everybody’s community in Gandhi’s waist approach to life, Habermas-like insights that are real and not self-deceiving, and Mezirowian non-binary thinking on what to do in dilemma situations—all of which align with my vision for a culturally sustaining education, in which local knowledge systems and those of the global village come together to enrich one another. Regarding socio-political concern, the Nepali critique of CDC's centralized curriculum development method exemplifies why policymakers, scholars, and teachers must cooperate on education policy-making and address systemic issues in the educational system. I am advocating that we democratize our approach to the design of mathematics curricula and reflect diverse cultural traditions on both sides that emerge from it by arguing that it is necessary for curriculum developers today to take up a stance that goes beyond content as subject matter alone. This perspective might be consistent with the broader endeavors to decolonize education and promote equity, providing a critical lens for reimagining mathematics education as transformative, just, and inclusive. Together, these insights establish the researcher's work at the nexus of theory and practice, thereby contributing to ongoing discussions regarding curriculum innovation, trans/disciplinary teaching, and equity in mathematics education.

Reflections

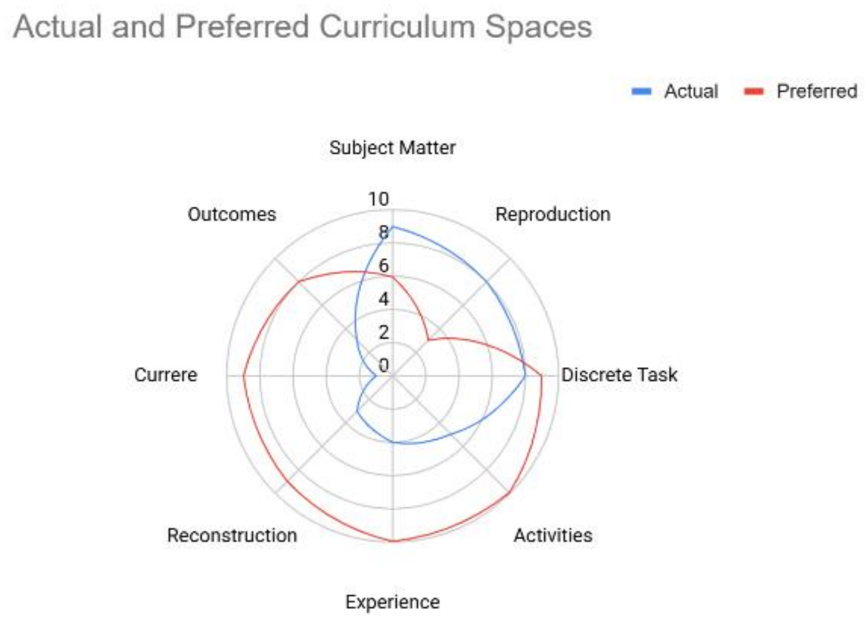
As a student, a teacher, an educator, and a STEAM scholar, I understand how curriculum spaces evolve. I learned that curriculum spaces contain content, pedagogy, and types of assessment and that these three elements influence how people learn. My work conducting teacher workshops and creating real-world-based classroom projects has shown me the importance of making math engaging and accessible to students. Working alongside mathematics embedded in research, the research participants, a critical friend, and teachers are instrumental as they utilize local knowledge systems and apply mathematical ideas and concepts that help make sense of curriculum spaces. The project budget and Rangoli activity also demonstrated how collaboration can make learning more joyful with students. In my research in the curricular space, local knowledge and global ways of knowing have intertwined. So, blending traditional working methods, such as the "Ropani" system, and more modern mathematical ideas has made me aware that students value their culture and understand that maths can be translated into any context. Teaching and learning math through the lens of its past does at least have the potential to make math easier to understand for students and more useful to them. And so, researchers like me can approach a transformative curriculum by combining the best of local knowledge and global knowledge. This method helps students connect math to the world and how they understand math. Collaborating between teachers, students, and the community is necessary to make the curriculum a meaningful space. By working together with all members of society, we can create learning experiences that are interesting, relevant, and motivating. Throughout the chapter, the effectiveness of projects such as budgeting and Rangoli demonstrates how teamwork is key in schools. To keep students engaged, math needs to be relevant to their lives. We make it more enjoyable and appropriate for students by relating it to culture and the real world. Students become equipped with the skills to build new ideals and campaign for their community through this approach.

Likewise, this chapter is rooted in three critical social theories: transformative learning theory (Mezirow, 1991), the knowledge that constitutes interests (Habermas, 1972), and critical pedagogy (Freire, 1970). These theories help me to understand the curriculum spaces in school mathematics. Transformative learning theory (Mezirow, 1991) helps to create curriculum spaces, considering that it fosters instructional change by making mathematics relevant to students' lives. This can be done by exposure to a wide range of mathematics classrooms that employ different teaching methods, planning learning units based on the student's interests to awaken their curiosity, and developing problem contexts that link mathematics to the real world. Furthermore, students' experiences and appreciation of mathematics are enhanced by integrating local and global knowledge systems. At the same time, the transdisciplinary approach allows for the transfer and application of mathematical thinking to different subjects. Collectively, these approaches contribute to a transformative learning experience: they facilitate powerful instances of students engaging in critical reflection on their assumptions while acquiring a more profound and connected understanding of mathematics. As a theorist who proposed the idea, I suggest that the conceptual framework of knowledge-constitutive interests (Habermas, 1972) offers avenues for the curriculum to address a shift from technical to emancipatory interest in instruction. This move will make mathematics more meaningful to students' lives by learning across varied classroom settings to study a variety of approaches to teaching, creating units based on students' interests to increase engagement, and having students engage in problem situation that situates mathematical ideas in real-world contexts, as I have described in this chapter. Furthermore, including local and global knowledge systems increases students' knowledge and understanding of mathematics. Transdisciplinary teaching also promotes the use of mathematics reasoning in other areas of learning. These strategies are congruent with Habermas's framework as they encourage critical reflection, practical application, and learning through questioning and acting out the development of what it means to know in mathematics.

Like Freire (1970), the mathematics classroom becomes a space for a dynamic interaction between students and mathematical concepts, not as abstract structures, but as concrete tools for perception and intervention in the world. Course development In

Designing a Unit of Mathematics Around Students' Interests, I have aimed to make mathematics meaningful and exciting. A geometry unit, for example, could examine the architectural features of nearby sites of interest, so that students can understand the real-life importance of angles and measurements. Again, generating word problems with authentic contexts, such as budgeting for a school event or analyzing statistical data to make sense of community issues, promotes critical thinking and problem-solving skills. This approach also facilitates the connection to local and global knowledge systems, as students might compare their insights with global trends, understanding the universality and diversity of mathematical applications. Furthermore, in the transdisciplinary teaching across mathematics section, I have invited the students to encourage them to draw connections between math and other subjects, such as science or economics, seeing the interconnectedness of knowledge. For instance, you can connect a math lesson on exponential growth to environmental science by modeling climate change projections. In this way, the mathematics program served as a vehicle for teaching to bring about instructional change and allow students to be involved in their learning and in society.

Thus, this chapter presents the mathematics curriculum of Nepal as a fusion of local and global knowledge, drawing on educational theory to promote innovation, creativity, and change. It resonates with Schubert's (1986) metaphors of curriculum as legacy, lived experience, and social change, in which traditional Nepali curricula prioritize abstract formulas. Still, ethnomathematics design projects incorporate cultural practices, and transdisciplinary teaching connects math to other disciplines, as curriculum as an instrument of societal change. I critique the overreliance on Nepali textbooks and advocate for curriculum spaces as a form of curriculum images (Schubert, 1986) that blend local systems with global concepts, aligning with dynamic, context-responsive curricula (see the adjoining figure). I have generated this map based on my experience as a student, teacher, and teacher educator. Likewise, Mezirow's (2000) transformative learning theory focuses on critical reflection and the change in perspective. For example, I draw out curriculum gaps at workshops for teachers as a way for the need for reform to come to light when (with dilemma situations) and embedded assumptions about practice among my research participants and I get unpacked. Tasks, including planning a budget and designing Rangoli, on the other hand, tap into rote learning, building problem-solving, and cultural pride. My transformative learning trace: a teacher transforming into a STEAM scholar, unfolds a shift from teacher to STEAM scholar and a focus on nurturing critical citizenship over content delivery. Not only that, Habermas's (1972) knowledge-constitutive interests critique Nepal's textbook-based, centralized curriculum and call for collaborative curriculum development and culturally responsive projects. Ethno-modeling and transdisciplinary challenge power structures and democratize knowledge production. These concepts have room for discussion by advocating shifting from technical to emancipatory models, echoing Gandhi's Swaraj (Gandhi, 1909). Freire's (1970) critical pedagogy stages—status quo, sensitization, and conscientization—are demonstrated in traditional math education, projects like budgeting, and Rangoli and Ropani projects. I have used problem-posing education, which aligns with Freire's dialogic methods, transforming students into active knowledge creators. Gandhi's Swaraj perspective (Gandhi, 1909)



maps onto the curriculum evolution of Nepal, from centralized curricula to collaborative teacher workshops, dialogues, and ethno-modeling and transdisciplinary teaching. My vision of "curriculum spaces" represents Swaraj, the cultural preservation and innovation meeting point. Finally, the Swa-Twam-Tat inquiry represents the personal self (Swa), relational selves (Twam), universal self (Tat) development, and teacher-student collaborations around the Nepali context and its relationship to global theories, advocacy for equity, and transdisciplinary teaching. The chapter is an attempt to (re)vision mathematics education as transforma- tive space of emancipation that integrates local knowledge with global frames of reference, and to challenge colonial legacies and technical hegemony, through such pillars as co-design, context responsivity, cultural relevance, and transdisciplinarity, echoing the calls for decolonized education worldwide and situating that of Nepal as a prototype of glocal synergy in nurturing innovators.

Chapter Summary

In this chapter, I have explored my learning experiences as a student, teacher, teacher educator, and STEAM scholar to examine the curriculum spaces in the mathematics curriculum. I realized that the mathematical concepts, topics, and skills imparted in mathematics education are integral to existing curriculum spaces. The wholeness of mathematical content that students are expected to learn, which is a blend of local and global knowledge, resides within these spaces. This chapter addressed the emerging research question: How have mathematical curricular spaces been developed by integrating local and global knowledge to foster innovation? Guided by transformative learning theory (Mezirow, 1991), and knowledge constitutive interest (Habermas, 1972), as well as critical pedagogy (Freire, 1970), I sought to reconceptualize the mathematics curriculum in a way that was more student-centered, relevant, and engaging. By integrating local and global ways of knowing, fostering collaboration, and contributing to transdisciplinary teaching, we can develop curriculum spaces that enable students to be innovative and think critically about mathematics.

CHAPTER V
EXPLORING SCHOOL-COMMUNITY RELATIONSHIPS AND THEIR ROLES IN ENGAGED PEDAGOGICAL PRACTICES IN MATHEMATICS

To teach is to engage students in learning; thus, teaching involves involving students in the active construction of knowledge. The aim of teaching is to transmit information and transform students from passive recipients of other people's knowledge into active constructors of their own and others' knowledge.

(David & Sweet, 1991, p. 165)

Taking David and Sweet (1991) in reference, I questioned, even now, why mathematics instruction in schools is predominantly delivered through traditional methods such as teacher-centric lectures, one-size-fits-all curriculum, conventional pedagogy, and decontextualized assessment. In this conventional format, information flows in one direction, from the teacher to the student, referring students to a passive role. Likewise, in Chapter Four, my inquiry focused on the need to develop a dynamic curriculum space for developing mathematics education as meaningful, innovative, and citizenry learning. Yet, another inquiry was felt the need to take up on pedagogy that engages students as per the dynamic curriculum space. Amid that background, this chapter examines engaged pedagogy as a method of alternative teaching of mathematics in schools, focusing on students' active participation and interest in learning (Lamichhane & Dahal, 2021). This includes hands- on mathematics manipulation, real-life problem solving by linking mathematics into life and cooperative learning to reorient pedagogical practices (Dahal & Pangeni, 2019; Dahal et al., 2022) in order to make mathematics more interesting and relevant to the lives of students. My understanding of engaged pedagogy is that it is a teaching approach that aims to enhance students' comprehension of mathematics and improve their problem-solving abilities in school and within their communities. However, the exciting phenomenon underlines a student-centered approach to teaching and learning. My visits offer a valuable opportunity to better understand the students' home lives, learning environments, and any challenges they may face. One of my research participants, Hari, stated, 'A home visit is the best strategy to engage students in learning mathematics, foster rapport among family members, and address both their common and uncommon interests.'

Moreover, engaged pedagogy is a foundation of STEAM education and can stimulate and ignite students' interest and motivation in learning and teaching mathematics. In STEAM-oriented mathematics education, engaged pedagogy is when one teaches maths in a way that will develop critical thinking, problem-solving, and creativity abilities through a multi-disciplinary to trans-disciplinary education acquisition approach (Monk et al. 2011). This approach has been increasingly embraced in Nepali schools and educational schemes.

Subscribing to the Bahuprasnavāda (i.e., multiplicity of questions related to the nature of engaged pedagogy), Bahurūpavāda (i.e., multiplicity of forms/perspectives arising from the idea of pedagogy itself), Bahuarthavāda (i.e., multiplicity of meanings of the same pedagogical category in different contexts), and Prājyanvāda (i.e., wisdom discourse that sees the connection of otherwise opposing views about pedagogy) with dialogic, poetic, metaphoric, and narrative logics offers a rich philosophical assumption for interpreting the exploration of the chapter of engaged pedagogy in mathematics. These concepts align with the emphasis of the chapter on dialectical spaces—dynamic, interactive arenas where knowledge is co-constructed through diverse voices, methods, and contexts. This chapter is the product of my introspection with myself as an individual self (i.e., Swa), research participants, and a critical friend as relational selves (i.e., Twam), inviting the readers as universal self (i.e., Tat) aligned to the question of how teachers, students, and the school community interact to co-construct mathematical learning experiences. And how do broader institutional, cultural, and policy contexts influence the development of engaged pedagogy in mathematics? So, this chapter employs a methodological approach grounded in three interconnected inquiries: Swa, Twam, and Tat. The Swa inquiry (First-Person) centers on my personal journey as a teacher and researcher, reflecting on the challenges and insights gained while transitioning from traditional, teacher-centric methods to engaged pedagogical practices. This self-reflection helps me critically examine my experiences, biases, and growth, offering a foundational perspective on the shifts needed in mathematics education. The Twam inquiry (Second-Person) utilizes interviews to engage research participants, teachers, students, and school community members, capturing their perspectives on school-community relationships and their impact on teaching practices. This relational approach prioritizes dialogue and co-construction of knowledge, ensuring diverse voices are heard and valued. The Tat inquiry (Third-Person) investigates broader contextual factors—such as institutional policies, cultural norms, and community involvement—through ethnography, document analysis, and comparative studies. It examines how these elements support or hinder innovative teaching practices. Together, these inquiries form a comprehensive framework of Swa-Twam-Tat, addressing the <u>emerging research question</u>: How are engaged pedagogical processes practiced and envisioned in the school mathematics classroom? Grounded on different perspectives and learning theoretical referents, I discussed the meaningful journeys of teaching and learning mathematics in multiple roles of ‘I’. These give me the ontological and epistemological vantage points of view to look at the way math is taught in a way that gets students interested in it. I have used Schubert (1986) to emphasize the richness of pedagogy through the metaphor of "multiple colors, aspects, and dimensions," likening it to the "petals of a marigold." Freire (1970) highlights the interconnectedness of education and reality, where the "colors of the world" and the "meanings of the word" merge, transforming the world into the word and vice versa, thus connecting the "riverbanks" of abstract and practical knowledge. Habermas (1972) calls for "uncorrupted power" and "authentic insight," urging educators to reflect on their roles within the system and to examine themselves critically. The Swaraj perspective (Gandhi, 1909) advocates for mutuality, co-living, and co-working, emphasizing the "sovereignty of

A Pedagogy of Many Colors

I have walked through marigold mornings, where petals whisper truths in hues—each shade a story, each fold a question, teaching in the silence between views.

Schubert sang in colors bright.
A tapestry of teaching rolled in gold, where pedagogy is not a line, but a bloom, with aspects layered, brave, and bold.

Freire led me to the river's edge. Where word and world entwine and flow, meanings bloom from rooted soil. And knowledge moves where real winds blow.

Habermas calls from deeper ground—seek not the power disguised in appearance, but truths that rise from honest mirrors,
and insight drawn from opened eyes.

The Swaraj path winds wide and near. With hands held in a woven chain, a garland of selves in sovereign bloom, in co-living, love, and shared refrain.

Mezirow’s voice, a compass steady, guides through doubt and inner fray—to question, choose, transform a new, and teach by living the better way.

So let us step with mindful grace, through gardens thought too wild to tame—and sow in soil both deep and shared, the seeds of learning.

selves" and the creation of a "garland of several flowers," symbolizing collective effort and connection. Mezirow (1981, 2000) stresses the importance of teachers developing competence to resolve dilemmas and seek better options. Freire (1970) further asserts that these competencies arise from the ability to transcend reactive behaviors and adopt approaches that benefit many. The Swaraj perspective (Gandhi, 1909; Narayan, 1928) also suggests that teachers should transcend ego and work collectively, as self-rule requires a collective effort. Habermas (1972) concludes that a key competency for teachers is to be aware of their unseen role in perpetuating an unjust system.

Engaged Pedagogy as a Dialectical and Multidimensional Space

Engaged pedagogy, a teaching style in math,
Where students are active, not passive.
But passivity is also needed at times.

It is a method that's hands-on, not just solving algorithms,
It is about critical thinking, not just memorizing concepts and processes.
But some memories need to be alive.

It is about engagement, not just compliance,
It is about learning, not just attendance.
But some compliance is also needed.

It is about the formation of a community, not just a classroom,
It is about inspiring curiosity, not just feeling meaninglessness.
But meaningfulness and meaninglessness are connected.

Engaged pedagogy, a teaching style in mathematics,
Where students are active, not passive.
But students need to feel and become passive.

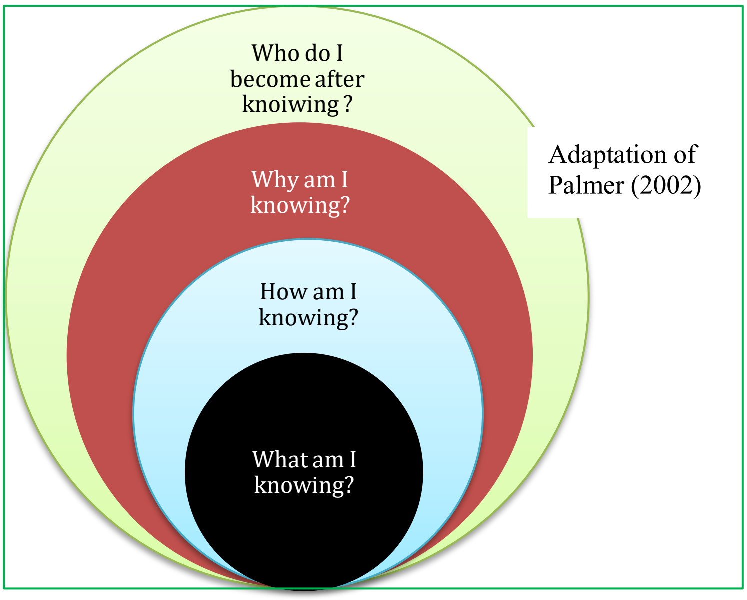
(Personal Diary, March 2021)

While portraying the *Karma (i.e., doing)* and *Dharma (i.e., valuing)* of my inquiry into engaged pedagogies, the poem reflects multidimensional and dialectical perspectives on engaged pedagogy in school mathematics. My research participants—Aarati, Kamal, Hari, and Santosh agreed that engaged pedagogy is the foundation for offering student-centered (does not mean that teachers do not have a role) teaching and learning in mathematics. Aarati summarized that students were motivated to learn mathematics when they could apply their learning by using their skills and knowledge. Students can excel in technical knowledge of finding simple and compound interests. They can visit the local Saving and Credit Ltd. and banks to develop their practical knowledge and skills in calculating the interest daily, from monthly to quarterly, semi-annually and annually.' Kamal added that 'assigning such a project in mathematics could drive the students into active learning.' Likewise, Hari added that 'parents are the key driver for promoting students' engagement in secondary level mathematics learning. He further added that result-oriented instruction accepted by the parents in the school mathematics is the key challenge for the students.' Santosh claimed that 'integrating the mathematics concepts of local area followed by the field visit improves the learning engagements of the learners in school mathematics.'

Alternatively, reflecting on Aarati, Kamal, Hari, and Santosh, they disclosed that engaged pedagogy connections among theory, practice, and sociocultural context in mathematics teaching and learning. Their perspectives invite a deeper exploration of the tensions, synergies, and cultural dimensions while implementing engaged pedagogies, thereby needing a dynamic curriculum space created as a composite curriculum image (see **Chapter IV**). They have emphasized student-centered learning. Aarati's focused on applying mathematical concepts, such as calculating interest at local banks. However, that aligned with experiential learning theories but raised questions about its objectives. Is the goal a functional numeracy, or can such tasks foster critical inquiry as Habermas suggests becoming an autonomous agent for change? For instance, students might analyze systemic inequities in loan structures while calculating interest, merging mathematical skills with social critique. This shifts 'application' from passive skill replication to active engagement with real-world justice, a step toward Freire (1970) critical pedagogy. Kamal's advocacy for project-based learning produces constructivist principles, yet projects risk becoming performative without student ownership. How might students co-design projects around community issues, such as budgeting for local infrastructure or analyzing agricultural yields, as Gandhi suggests? This process might democratize the curriculum (e.g., curriculum as reconstruction!), positioning learners as knowledge producers rather than consumers, a core tenet of Deweyan democratic education

(Dewey, 1916). Hari's observation about parental pressure for scores-oriented instruction' exposes what Mezirow calls a dilemma that may require an inclusionary shift for the broader goal of teaching for and with critical consciousness. While families often prioritize exam success, this can counter an engaged pedagogy de-emphasizing process and creativity. Bridging this gap requires dialogue: educators might showcase how engagement enhances deep understanding and, thus, long-term academic success or involve parents in project exhibitions to reframe their metrics of 'results.' Santosh's emphasis on integrating local contexts, such as field visits, challenges the Eurocentric abstraction often dominating math education. Educators can decolonize curricula and affirm students' cultural identities by grounding concepts in glocal knowledge, such as geometric patterns in traditional crafts or ecological data from local ecosystems, where learning connects to learners' realities. My poem possibly invokes Dharma (duty/ethics) and Karma (action/consequences) and invites reflection on teachers' moral responsibilities which is not guided by binary opposites. Perhaps engaged pedagogy becomes an ethical imperative for us: educators must balance institutional demands, such as exams, with their 'dharmic' duty to nurture curiosity.

Arriving at this stage, I sense that 'Karma' manifests in how pedagogical choices—rigid instruction or/and collaborative pedagogy of construction—run in students' lifelong relationships with mathematics, as Parker Palmer (2002) asks four questions reflecting his pedagogical experience while a student. I feel that engaged pedagogy in mathematics is a methodological shift for reimagining education as knowing in a cooperative, context-sensitive ecosystem in which local contexts and issues enter the mathematics classroom as I reflect on activities that focus on what, how, why, and who of the knowing. As shown in the adjoining figure, taking the example of teaching parallel lines,



students might start looking into the content and foundational dimension of knowing, followed by the emphasis on the processes depicted in the 'how' of knowing, such as drawing, dialoguing, questioning, and reflecting. The third layer would be reflected in the relevance of knowing parallel lines as the justificatory 'why' dimension. Finally, they may look into how they can connect directly to their lives as they are in the process of knowing. The relational approach demands partnerships among students, teachers, families, and communities to transform mathematics from a detached discipline into a tool for empowerment, critique, and cultural affirmation. When critically examined, the participants' insights sought both possibilities and paradoxes—a call to navigate complexity with creativity and ethical intentionality as they need to work with the regime of narrowly conceived notions of assessment and desire to transform their pedagogy to be engaged. These perspectives highlight a range of student-centered teaching and learning methods, referred to as 'Engaged Pedagogies' in Russ Edgerton's 2001 White Paper (Edgerton, 2001). Engaged pedagogies are characterized by design thinking, innovative pedagogical approaches, purposeful and meaningful practices aligned with the learning modules, outcomes, and assessments. Empathize, define, ideate, prototype, and test solutions of real-world challenges; design thinking in education aims to foster creativity and problem-solving by encouraging students. It is believed that innovative pedagogical approaches transform traditional teaching methods by integrating technology (but being aware of its imposing redesign), collaborative learning, and inter/disciplinary projects to enhance student engagement and learning outcomes. I have used and felt that these pedagogies promote interaction between students and instructors, encourage active learning, and respect diverse talents and learning styles (Edgerton, 2001; Pant et al., 2020). Such pedagogy hopefully enables students to participate actively in their learning process. This could involve group projects, hands-on activities, and other forms of active learning to create a more meaningful and relevant learning environment (Mohd & Shahbodin, 2015). Perhaps, it assists students in acquiring the skills and knowledge necessary for present and future life in their careers and personal lives. For instance, a critical friend, Naresh, added that 'the benefits of employing an engaged pedagogy may include increased student motivation, enhanced critical thinking and problem-solving skills.' However, I felt that we need to resolve marks versus creativity through a carefully designed composite curriculum image that balances traditional demands within a progressive curriculum space. Thus, school mathematics teachers, despite implementing engaged pedagogy in their classrooms through various strategies, including project-based learning, inquiry-based teaching, and integrated STEAM projects, need to pay attention to the traditional assessment demands even if with a small weightage

Purposeful Practices of Engaged Pedagogies

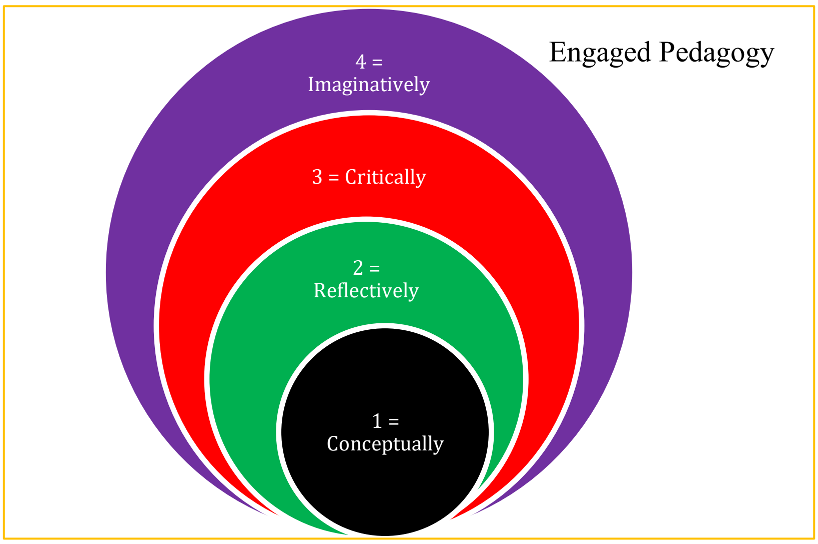
It is a practice that is experiential, not just algorithmic problem-solving,
But the algorithm is also needed.
It is about analytical thinking, not just reciting mathematical facts.
But also, about post-analytical thinking.
It is about participation, not just obedience,
But some degree of obedience is needed.
It is about learning, not just presence.
But presence is also needed.
It is about cultivating innovation, not just repetition,
But a certain degree of repetition is needed.
It is about real-life relevance, not just mathematical facts.
But mathematical facts are also needed.
It is about building a culture, not just space,
But space is also important to create a culture.

(Personal Diary, April 2022)

The poem above depicts possible lenses of engaged pedagogy that might be the pedagogical process for engaged mathematics learning. I am aware that engaged pedagogy in school mathematics is for fostering both an understanding of mathematical concepts and excitement for learning mathematics among students by involving students in the learning process (Colville et al., 2021). One of my critical friends, Naresh, added that 'mathematics teachers could create a dynamic and engaging classroom environment that encourages students to take responsibility for their learning and develop their mathematics skills to their fullest potential.'

However, these views contradict existing practices of engaged pedagogies in school mathematics. How can the principles of engaged pedagogy be effectively integrated into mathematics classrooms to enhance conceptual (and beyond) understanding? How can mathematics teachers create a dynamic and engaging classroom environment that encourages students to take responsibility for their learning? What are some practical strategies for involving students in learning to develop their mathematics skills to their fullest potential? What role does the sociocultural context play in implementing engaged pedagogy in school mathematics? How can educators balance the need to foster excitement for learning mathematics to deepen students' understanding of mathematical concepts? I am attempting to bring such practices from my inquiry to the mathematics education community. Some of the events I recall from my experiences as a learner, teacher, STEAM educator, and researcher that effectively engaged students in learning mathematics—while also strengthening the connection between the school and its community—include parent-teacher meetings, home visits by mathematics teachers, curriculum evenings, and various school events such as exhibitions, talent shows, writers' clubs, math centers, math clubs, and mathematical Olympiads. Additionally, guest lectures by parents and community service initiatives have also played a significant role in fostering an engaged and collaborative teaching and learning environment in school mathematics. STEAM educators integrate science, technology, engineering, arts, and mathematics to create interdisciplinary learning experiences that foster students' creativity, critical thinking, and problem-solving skills. My research participant, Aakriti, also took students to the carpenter factory to engage them in conceptual understanding of the mensuration concepts of mathematical ideas and concepts.

Various student-centered teaching and learning methods are called *engaged pedagogies* (Smith et al., 2005). Despite my focus on engaged pedagogy, I do not mean to say engagement is none and all about the phenomenon. Drawing from Egan (1997), I feel that the characteristics of engaged pedagogies are helpful for the learners to expand their understanding conceptually, reflectively, critically, and imaginatively, as shown in the adjoining figure. I have clarified these through an example of teaching a two-variable equation through the adjoining figure. Conceptually



(i.e., 1), I would engage students in understanding the balance between the two sides together with the known and the unknown. Reflectively (i.e., 2), I help students connect such a balance or equation with the everyday lifeworld. Critically (i.e., 3) speaking, students can compare equations and inequalities in light of the distribution of resources. Imaginatively (i.e., 4), the idea of an equation could relate to model-making of variables as suggested in the practice of ethno-modeling (Adams, 2025). These approaches include innovative teaching approaches and meaningful practices that align with the educational goals of a dynamic curricular image as discussed in Chapter Four. While engaged pedagogies may offer many benefits, some argue that traditional teaching methods provide a more structured and consistent approach to education. They believe that a focus on direct instruction and standardized assessments ensures that students meet essential learning benchmarks and that the emphasis on innovative practices may sometimes overlook the importance of foundational knowledge and skills. Given the notion of multiple forms of knowing and understanding, I understand engaged pedagogy in mathematics classrooms as an approach to teaching and learning in which students are actively involved in the process of their learning and developing multiple forms of sensibilities, as suggested by Egan (1997) in the figure above. This involves group projects, hands-on activities, and other types of active learning (Davidson, 2021; Smith et al., 2005). I could comment that engaged pedagogy aims to create a more meaningful and relevant learning environment for students and to assist them in developing multiple understandings necessary for present and future lifeworlds. For instance, Kamal, a research participant, uncritically added that 'in the era of the digital world, our focus in teaching mathematics should be on engaged learning connecting the community.' My question would be: Is everything digital? I leave it to the readers!

Likewise, the critical friend, Naresh remarked that 'increased student motivation, enhanced critical thinking and problem-solving skills are among the primary benefits of employing an engaged pedagogy.' As per my experience, mathematics teachers implement engaged pedagogy in the classroom through various strategies, including project- and inquiry-based learning. However, how can mathematics teachers effectively implement project- and inquiry-based learning to enhance students' motivation and critical thinking skills? What strategies can be employed to foster problem-solving skills through engaged pedagogy in mathematics classrooms? In what ways does engaged pedagogy contribute to increased student motivation, according to Naresh's observations?

So, from teachers to parents and then to the community, pedagogical paradigms have been changing (Shah, 2018). This change is looking for a pedagogical innovation. Hinojosa and Bonner (2023) remarked that aligned with my research participant, Santosh, studying mathematics involves forming collaborative relationships with parents and community members and addressing the wider social aspects of educational environments, possibly the why and who of the learning process. Additionally, Aarati, one of the participants, added that 'focus on personal factors like the order and support of learning activities, the significance of the subject matter, the creation of tasks, and the progression towards shared curricular goals.' So, the goals of these pedagogies are to motivate students to engage in the active learning process of mathematics from school education to higher studies. Similarly, the discussion highlighted the importance of pedagogical innovation in mathematics education, emphasizing the creation of collaborative partnerships with parents and communities, addressing broader social dimensions, and nurturing students' personal qualities. These efforts aim to inspire active student engagement in learning, positioning school as a foundational stage for success in school education and beyond.

"It seems to us that classroom culture may be a more important determinant of participation than the curriculum, methods of teaching, modes of assessment, teacher experience, and availability of resources." (Sullivan et al., 2006, p. 97). In this regard, Wright (2017) highlighted "how conventional approaches to teaching mathematics contribute towards alienating a high proportion of learners and reproducing inequities within society." (p. 515). In this line, Butin (2010) highlights community-engaged pedagogy's technical, cultural, political, and post/foundational aspects, which might challenge the conventional notion of knowing what and embrace how, why, and who of knowing, as shown in the picture above Here post/foundational aspect refers to my realization of a complementary relation between the discipline of mathematics and expanding limitations of the disciplinary borders to unpack multiple pedagogical possibilities in mathematics. Perhaps, this is akin to Mezirow's idea of perspective transformation in conceiving and applying engaged pedagogy in mathematics education.

Taking Freire's idea of a pedagogy of hope at the disposal, community-engaged pedagogy brings hope by focusing on practical, hands-on learning experiences connecting academic content with real-world applications, focusing on the practical interest of Habermas. It is likely to value and integrate different cultural perspectives and knowledge systems, fostering an inclusive learning environment in which they can question and challenge for open inquiry, an exegesis to Freire. However, empowering students to become informed, active citizens offers room for critical examination of power structure issues by challenging the traditional curricular images, promoting flexible, adaptive, and context-sensitive pedagogies, and reflecting its post/foundational orientation. Likewise, I hope that community-engaged pedagogy focuses on students learning with the help of the community. Culturally, community-engaged pedagogy aims for students to collaborate with community members to understand better who they are concerning the local population and become more aware of their privilege (Curtis, 2012).

Student engagement is very important to their academic success and could be improved by classroom pedagogical techniques (Astin, 1993); how mathematics teachers enact the curriculum could increase student active engagement and knowledge acquisition, making it more important to student learning than the content (Astin, 1993). Pedagogical approaches in mathematics include methods such as direct instruction, collaborative learning, inquiry-based learning, and project-based learning, all designed to enhance students' understanding and application of mathematical ideas conceptually, critically, reflectively, and imaginatively. Thus, engaged pedagogy is vital to any rethinking of education because it holds the promise of full participation on the part of students (Curtis, 2012). Moreover, Hari, one of my research participants, added that ‘engaged pedagogy establishes a mutual relationship between teachers, students, and even community people that nurtures the growth of all parties, creating an atmosphere of trust and commitment that is always present when genuine learning happens.’ Expanding among head (know), heart (feel), and hands (do) terms as 3-H (Dahal, 2022b; Inan & Inan, 2015), engaged pedagogy hopefully makes better learners because it embraces and explores the practice of knowing together to see intelligence as a resource that could strengthen our common good and/or goal with expanded focus on knowing what, how, why and who (Inan et al., 2015).

For some examples of teaching practice of engaged pedagogy, Naidu (2014) commented that effective and engaging teaching techniques establish the connections between the mathematics curriculum as lived experience and the students’ experiences in the real world through "engaged" teaching and working to inspire the students to develop reflexive and critical thinking as societal participants. Meanwhile, my research participants and I debated that engaged pedagogical praxis arises from a teaching philosophy based on the conviction that teaching and learning are collaborative processes involving the teacher, students, and even the community. Thus, I added that engaged pedagogy could be used in the classroom in a few ways with the help of community people, such as through inquiry-based teaching and project-based learning (Rasa et al., 2022; Shah, 2018). Subsequently, I realized the need for a framework of engaged pedagogy for schoolteachers and the community in mathematics. Near the end of this chapter (See Figure 9), I attempted to propose an emergent model of engaged pedagogy for school mathematics.

Home Visits as/for Engaged Pedagogy

As a high school math teacher, I had just finished grading my students' first terminal examination for grade 9, which was taken in May 2021 on one of the Mondays of May 2021, and I was worried about how they did. I felt that many students were having trouble with the ideas I had taught them about the factorization of algebraic expressions and were not doing well on their tests. Sitting in my chamber and thinking about possible solutions, I decided to help students. I thought about what other teachers had said about making home visits to their students. I, too, decided to give it a try. So, I chose the students who had below-average marks on their tests and made plans to see them at their homes. I did this because I wanted to learn more about their home lives and any problems, they had that might hinder their learning.

I started my first home visit with Raju, a student who has always had trouble with mathematics. I reached his house without any difficulty as I was familiar with it. Surprisingly, his parents were happy to see me! I told Raju why I was there and asked him how well he understood the ideas I had taught in class. Raju said that his older siblings, who were often loud and distracting, made it hard for him to pay attention in class. I understood Raju's situation and gave him some tips on how to handle distractions in class better. During the visit, I also noticed that Raju did not have a computer or internet at home, which made it hard for him to do his online homework. I worked with Raju's parents to devise a solution and ensured he could use a computer at school. After the visit, I felt I knew more about Raju's problems at home and could better teach him. I also felt like I knew Raju and his family better, which helped them trust and talk to each other better. I continued to visit my students *at home throughout the school year and saw a big improvement in how well they did in math. I also got good feedback from my students and their families, who liked that I tried to understand their situations and help them in a way that was right for them. My home visits were successful and helped me learn more about my students' needs to improve their mathematics learning.*

(Personal Diary, May 2022)

While reflecting on the narratives, I realized that home visits help students do better in school in mathematics (Chavkin & Williams, 1988; Epstein et al., 2004; Henderson & Mapp, 2002). My visits offered a chance to learn more about the students' home lives, learning environments, and any problems students might have. For instance, Hari, one of my research participants, stated that a 'home visit is a good strategy to engage students in learning mathematics, developing the rapport among the family members and for serving their common and uncommon interests.'. These engagements have improved the rapport with students. Raju (a student) said, '*I am delighted to see you in my home to help me improve my mathematical concepts.*' Likewise, these processes could help mathematics teachers plan better ways to teach and help the students (Henderson & Mapp, 2002). As per my experience, mathematics teachers receive minimal support from parents in the students' learning process. It is like a '*let it go*' approach. My research participants and a critical friend never attempted this approach to develop rapport with the students, parents, and community as they might not have gone beyond teaching the words rather than the worlds of students as Freire suggested. However, they know its importance. I realized that home visits have been shown to help students feel better about mathematical concepts and be more motivated to learn, but they have not been practiced as such. I believe home visits also help to close the gap between the home and the classroom and make it easier for teachers and parents to talk to each other and work together (Epstein et al., 2004) to serve the common interest of helping the students to perform better in mathematical ideas and concepts.

Henderson and Mapp (2002) commented that mathematics teachers who went to their students' homes were better able to tailor their lessons to each student's needs and give targeted help. This led to students getting better at mathematics and doing better in school. Home visits by mathematics teachers are a great way to help students improve their mathematics skills, attitudes, and motivation.

Smith and Akos (2007) found that home visits by mathematics teachers helped students become more interested in mathematics and do better in it. The home visits got parents more involved in their children's overall development in mathematics and changed how they felt about school and teachers. As I am coming to the end of this reflective journey, my poetic ‘Swa’ speaks this way:

Home is the world more like a commune
Making school as a space for union
Where is community there is education
Gandhi would go for becoming sovereign!

Hopes are for all without fear
Asking questions for the present and future
Where is home there is learner
Freire would ask teachers and learners to become truer

Shifts are necessary to travel beyond the abyss
Undoing the logic of either or and duals
Homes can deal with the dilemma by hyphens
Mezirow would ask teachers and learners to create lenses

Engaged Pedagogy via Parents Engagements in School Events

It could be any day in June 2020. The school where I teach secondary mathematics is preparing for the Curriculum Eve event for the new academic year. This was my first event ever as a secondary math teacher. This event was a chance to show off the mathematics curriculum I have been teaching and/or working on all year, and show students how far we have come. I focused on the curriculum, pedagogies, and minor and major events in mathematics, which were often the event's focus. The school had been trying to improve mathematics teaching and learning for a long time, and they were proud of their progress from the time the school was established. On Curriculum Eve, the school administrator set up tables and displays to show off students' work, and the displays explained how I had taught different concepts. In an informal discussion with the parents, I discussed how important it is to build a strong mathematics foundation and how hands-on activities and real-life examples could help students understand abstract ideas. During my presentation, *parents and community members were impressed by how far the students had arrived at the level, and many said that their children were much more confident and capable in math than they had been before. As the event went on, I discussed the academic year plan. I also had the chance to talk with parents and share ideas about improving math learning at school. I discussed the importance of ongoing professional development, the benefits of using technology to improve learning, and the need to ensure that all students receive high-quality mathematics instruction. Lastly, I reflected that Curriculum Eve was a success, and I left feeling inspired and motivated to keep going at the same pace and speed. Parents knew that there was still a lot to do to ensure all students had the mathematics skills they needed to succeed in the future, but they were committed to the task and eager to keep moving forward.*

(Personal Diary, July 2022)

I acknowledge that events such as Curriculum Eve might help the mathematics teacher know more about student learning opportunities. It is an event designed by class teachers to share the overall activities of the academic year with the parents. There was an attempt to show that our curriculum planning integrated some innovative and interdisciplinary activities that foster critical thinking and creativity as a way for teachers to engage their children in the academic year. We also promised student-centered learning experiences related to academic content and their real-world applications, promoting lifelong learning and adaptability. Upon reflection, there was a reflection of curriculum as experience and activities together with curriculum as content. However, my research participants and my critical friend do not have such experiences. Still, they agreed that this is one of the strategies to get to know the parents of their students to plan teaching and learning activities for the learners. Next, these are learning opportunities that directly impact mathematics teachers' professional development positively (Han & Wang, 2010). Mathematics teachers get the chance to showcase their ability to facilitate mathematical learning to their parents by engaging them in pedagogical activities.

In specific cases of teaching and learning mathematics, I realized that sharing the major and minor events, projects, hands-on activities, and real-world examples for the academic year brings the curiosity of learning mathematics to enhance students' comprehension and retention of mathematical learning (Fuson et al., 2015). Lastly, curriculum eve-like events may help improve mathematical learning, which appears to be a key approach in closing students' learning gap by involving the parents.

Poetically speaking, I sense -

Engaged pedagogy-
Coming together
Doing together
Seeking together
Yet, becoming engaged to be-
Aware of possible deceptions
Cognizant of inner voice
Conscious of masks
Seer of possible distortions

Expanding the Sphere of Engaged Pedagogy: Guest Lecture from Parents

On a typical Tuesday morning in the middle of June 2022, ninth graders filed into my mathematics class, chatting and laughing. As they had been informed that the parents of one of their classmates would be offering a guest lecture today, students were unaware of what to expect from the lesson. The parents of one of the students, named Radha, entered the classroom, greeting all the students as they settled into their seats. They explained that they were there to discuss the importance of mathematics in daily life and how it would assist them in future endeavors. Some students were laughing, while others were serious about the issue as they shared their agendas. One after another, the parents began by introducing them and emphasizing the importance of a strong mathematics foundation. They explained that areas of mathematics such as arithmetic, algebra, home arithmetic, geometry, and trigonometry were crucial for success in various fields. They encouraged the students to pay attention and regularly practice mathematics to develop the foundations.

One after the other, the parents discussed the importance of problem-solving skills in mathematics. They explained that by breaking down complex problems into smaller, more achievable steps, students could learn to identify the key variables and comprehend their relationships by sharing one example *of the factorization of an algebraic expression. In addition, they emphasized that these skills were useful in mathematics and many other areas of life. They also discussed their methods for learning mathematics from elementary to high school. The parents highlighted the importance of approaching mathematics positively as the lecture progressed. They acknowledged that some individuals may view mathematics as boring, challenging, or irrelevant to their lives. Nonetheless, they argued that mathematics is an exciting subject with different applications in real life. Students could discover the charm of mathematics' logic and structure if they approached it with an open mind and a willingness to learn.*

The parents, one after the other, encouraged the students to pursue their mathematical interests and passions after the lecture. They recommended joining a math club, Olympiad, or STEAM club, or competing in mathematics competition activities to meet other students with similar interests. They reminded the class that pursuing their passions in mathematics could open countless doors that could lead to successful careers in various fields. The parents thanked the students for their attention and suggested that they continue their mathematics learning. The students left class that day with a new appreciation for mathematics and a desire to pursue their interests.

(Personal Diary, July 2022)

This is yet another attempt to encourage students to study mathematics at the school level during my tenure as a secondary-level mathematics teacher. Students would be exposed to various perspectives and applications of mathematical concepts in the real world if parents gave guest lectures in mathematics classes on topics such as home arithmetic, simple and compound interest. From my experience, the possible benefits of conducting guest lectures from the parents could be that they could bring their natural expertise and experience to the classroom, broadening the scope of what students learn; students could see how math is applied in various professions. So, the guest lectures could help foster a sense of community and collaboration between parents and teachers (Shah, 2018).

Hari, one of the research participants, added that 'this is a new way to motivate the students in mathematics learning. I will try this approach in my future class, which best fits the curriculum.' However, the guest lecture needs to align with the curriculum and learning goals. The lecture must be well organized and prepared to share the intended message to the students so that they engage in the discussions later. It is also advised to ensure that all students feel included and engaged during the lecture, regardless of their background or prior knowledge of the topic. Before allowing guest lectures in the classroom, obtaining permission from parents and/or the school administration may be necessary, depending on the school's policies, rules, and regulations. For instance, a critical friend commented, 'a guest lecture by a parent in a mathematics class could be a valuable addition to the learning experience, but it must be approached thoughtfully and with care to ensure that all students benefit and are motivated.’

Parent-led guest lectures in mathematics classes may offer various benefits and challenges. Teachers may see potential for curriculum alignment and community building but worry about quality control and equity issues. Students appreciate real-world relevance and novelty and may face disengagement or anxiety if the lecture is not participatory and interactive. Parents feel pride and involvement but may struggle with teaching dynamics and time constraints. Administrators value community engagement and policy compliance, though logistical hurdles and accountability are concerns. Researchers highlight theoretical benefits and skill transfer but caution about evaluation and bias risks. Critical friends stress inclusivity and care, while curriculum developers may focus on alignment and scalability. At this juncture, I reflect thus,

If someone-
Speaks for a select few
Speaks alone
Listens less
I would not invite for-
A walk together
A speaker turn-by-turn
A speech and questions
A combination of mouth, eyes, and ears!

Parent-Teacher Meeting as Promoting Engaged Pedagogy

It could have been any day in March of 2020 when I sat down with Aryan's (pseudonym) parents to talk about how he was doing on his half-yearly math exam in PTM (parent-teacher meeting). As I have been his mathematics *teacher for this academic year, after the greetings and taking seats by parents in the meeting room, I started the meeting by giving Aryan's test scores, pointing out that he did well in algebra but struggled with geometry (concepts of circles). I told them that Aryan had been working hard in class and asking questions when he needed help in math and outside of math class. I also shared Aryan's other talents of performing, such as dancing and acting. Even in some classes, I requested him for some forms of refreshment, and he had performed well to refresh. However, other than talents, the parents were worried about how well Aryan was doing in mathematics, especially in geometry, rather than other talents, so they asked me how they could help him learn at home. I told them that Aryan should do more geometry problems with circles and gave them a list of websites to help him. I also told Aryan that if he needed extra help, he could come to see me after school or work with a tutor. Then, I told Aryan how important math is in the real world and how it could help him get many different jobs in the future. During the meeting, I told Aryan to continue working on building a strong foundation in mathematics. I also reminded him that making mistakes is okay and that learning from them is part of the learning process. At the end of the meeting, Aryan's parents thanked me for my advice and asked me to take even better care of their son. I told them what they would be learning about, like trigonometry and statistics, and reassured them that I would monitor Aryan's progress and talk to them if I had any worries. I reflected that the meeting with Aryan's parents went well and helped me work together to help Aryan do well in mathematics at school and even at home.*

(Personal Diary, March 2020)

This is my first meeting with Aryan's parents. The experience I described above pertains to the first students present at that parent-teacher meeting on that day. I never imagined such a gathering and sharing of students' possessions and the need to work in mathematics subject areas. While reflecting on the meeting, as a mathematics teacher, I explain the purpose of the meeting and inquire whether the parents have any specific concerns or questions regarding their child's mathematics performance, including the student's academic progress in mathematics, grades, class participation, and other talents. In addition, I provide specific examples of the student's work, such as homework, class test papers, and other skills, to help parents understand their children's academic performance.

I also discuss the students' mathematical skills, such as comprehending and applying mathematical concepts, solving problems, and effectively using mathematical formulae and algorithmic steps. I needed to do this as I need to survive as a teacher so that I can chart the journey of becoming a practical and emancipatory teacher (Watson et al., 2025). If the student has difficulty in any of these areas, I provide suggestions for how the parents could assist their child at home. I have discussed the mathematics curriculum and the topics already covered so far. I describe the curriculum structure and its alignment with the curriculum. Throughout the meeting, I provided suggestions on how parents could support their child's mathematics development. This may include online mathematics games, math applications, YouTube channels, and mathematics tutors. The meeting concluded with the parents being invited to ask questions or express concerns. I also provide additional resources or referrals to support the academic and personal development of the student.

However, my research participants and a critical friend do not have such experiences of connecting to the parents, but they agreed that this could be one of the other ways to share the student's overall progress in mathematics and offer appreciation and feedback to the students for improving their learning experiences. Thus, I believe parent-teacher meetings are essential for communication and collaboration between parents and teachers in mathematics for engaged pedagogy The meetings between parents and mathematics teachers are advantageous for both parties, as they could provide insight into the student's learning and aid in developing strategies to support the student's academic advancement. For instance, Hinojosa and Bonner (2023) added that the "stories on how teachers, parents, and children engaged in conversations around mathematics helped children to connect to mathematics more explicitly." (p. 235). Flink et al. (2014) argue that parent-teacher meetings in mathematics could help children develop a more positive attitude toward the subject. This could be accomplished by discussing their subject-area strengths and weaknesses, setting attainable goals, and creating an action plan to enhance their performance. Likewise, Boukari et al. (2015) commented that parent-teacher meetings in mathematics could aid in the development of children's mathematical reasoning and problem-solving skills. This could be accomplished by discussing the applications of mathematics in the real world by providing examples of how mathematics is used in daily life and encouraging children to approach problem-solving creatively.

Borba et al. (2016) emphasize the significance of parental involvement in children's mathematical reasoning and problem-solving skills. This could be accomplished through regular communication between teachers and parents, collaborative problem-solving tasks, and providing resources and support for parents to assist their children at home. Thus, parent-teacher meetings in mathematics significantly impact a child's learning, as they promote positive attitudes toward the subject, foster problem-solving skills, and encourage collaboration between parents and teachers. Parents and teachers could support children in succeeding in mathematics and developing lifelong learning skills.

Parent-teacher meetings are generally beneficial for all the parties--learners, teachers, and parents; they may not be equally effective for all families due to cultural norms, socioeconomic status, and parents' educational backgrounds. Parents with limited formal education might feel intimidated or excluded, hindering meaningful engagement. In my experience, low-income families are juggling multiple jobs. Their not flexible engagements may struggle to attend meetings, which leads to inequities in parental involvement. In our cultures, questioning a teacher's authority and having collaborative dialogue is inappropriate. Thus, the benefits of parent-teacher meetings may not favor all families, raising concerns about inclusivity. Indeed, formal meetings can overlook the value of informal, ongoing communication, as digital alternatives like apps, messaging platforms, or asynchronous updates can provide more frequent, low-stakes opportunities for feedback. Thus, a hybrid model blending meetings with digital engagement might be an alternative for sustaining this for diverse families. Arriving at this stage, my poetic 'Swa' reflects thus:

Did I listen to them?
Did I provide them to speak?
Did I prepare to learn?
Did I dialogue with them?
Did I learn something after the meeting?

Math Club as Promoting Engaged Pedagogy

It could be any day in November 2021, on one of the teacher's professional development sessions. Ms. Pema (pseudonyms), a newly appointed full-time trainer at the school, conducted a session on farming, designing, and working in the math club. At the beginning of the session, she theoretically introduced *the concepts of the math club and engaged us in math club activities later in the session. I am reflecting now on how curious I was to be part of the learning team. While reflecting, I was so excited to be a part of the math club at school as a trainee, where I have been a secondary mathematics teacher since 2015. As soon as I heard about it, I knew I had to join the session by managing my time. Since I was in school, math has always been my favorite subject, and I love the challenge of solving complex mathematical problems with algorithms.*

During training for the math club, other mathematics teachers at the school and I started the meeting by introducing ourselves and talking about our favorite areas of math. I was surprised that some of the other mathematics teachers were interested in different areas than I was. One teacher loved geometry, while another was really into arithmetic. It was interesting to hear about everyone's interests and experiences. After our introductions, Ms. Pema gave us a challenging problem to solve. The mathematical algorithm problem involves algebra and requires us to think creatively about approaching the problem. It took us a while to get started, but we worked together and eventually figured it out. It was such a satisfying feeling when we finally got the answer. Next, we split into smaller groups to work on individual projects. I chose to work on a project about the experimental exploration of the concepts of circles. The concepts have always fascinated me, and I wanted to learn more about their properties and patterns. I spent the next hour researching and working on my project, and I was surprised by how much I learned. At the end of the meeting, we all shared our progress and what we had learned. It was so interesting to see what everyone had been working on. Some teachers had created models of geometric shapes, while others had been studying data science. Seeing how much passion and dedication everyone had for math was amazing. Near the end of the session, I shared my experience as incredibly rewarding for engaged learning in mathematics on the training floor. Not only have I learned about math, but I have also developed a rapport with my friends. In the session, I cannot wait to implement the concepts of the math club.

(Personal Diary, November 2022)

Engaged pedagogy is a teaching and learning strategy that emphasizes developing students' cognitive and affective skills (Gilliams, 2015). As I participated in the math club, I realized that learning involves more than just acquiring knowledge; it also involves developing the skills to think critically, communicate effectively, and collaborate with others. Perhaps, these soft skills are equally important for teachers to help challenge false consciousness about students’ perceived weaknesses about themselves as learners, facilitating a shift in students’ identities as engaged learners, building communities across the students’ groups, and challenging the language game of learning as depositing ideas for later use.

For instance, Kamal added that the ‘mindset of the traditional curriculum, pedagogy, and assessment must be revisited by seeking alternatives while nurturing 21st-century learners.’ A traditional curriculum (i.e., curriculum as subject matter) underlines a uniform set of knowledge and skills that students are required to master—traditional pedagogy features teacher-led instruction, with the teacher as the main information source. Traditional assessment methods depend on exams and tests to evaluate students' comprehension and performance according to prescribed content. Thus, curriculum, pedagogy, and assessment are the factors behind implementing engaged pedagogy. The curriculum, such as curriculum as experience, curriculum as inquiry, curriculum as social reconstruction, and curriculum as autobiographical journey, may emphasize the development of critical thinking and problem-solving skills by creating learning experiences relevant to students' lives and interests. Pedagogies beautify the overall approach to teaching and learning and involve both the teacher and the student in active participation. This includes group discussions, collaborative projects, and other interactive activities that encourage students to take an active role in their learning at their own pace, in their own time, and in their environments. Techniques provide specific strategies and tools that promote the development of cognitive and affective skills. Students are encouraged to reflect on their thought processes and emotional responses using role-playing exercises on fictitious markets, reflective writing assignments, and other activities (Garrett, 2018; Grierson, 2015). Consequently, I could write that engaged pedagogy is an approach to mathematics teaching and learning that prioritizes the development of students' cognitive and affective skills by concentrating on curriculum, methodology, and techniques.

Hooks (1994) argues that engaged pedagogy is a critical approach to teaching and learning that emphasizes the significance of creating an open and inclusive classroom environment and encourages students to take an active role in their learning. Freire (1970) comments that traditional educational systems are frequently oppressive and challenging traditional educational structures to establish a more democratic and equitable approach to education. Engaged pedagogy is an approach to teaching and learning that could help students develop the cognitive and affective skills they need to succeed both inside and outside the classroom. Even mathematics teachers could help students become active, engaged learners who are prepared to navigate the complexities of the contemporary world, even in mathematics classes.

Engaged Pedagogy in School Mathematics: What Is to Be Included (or Not)?

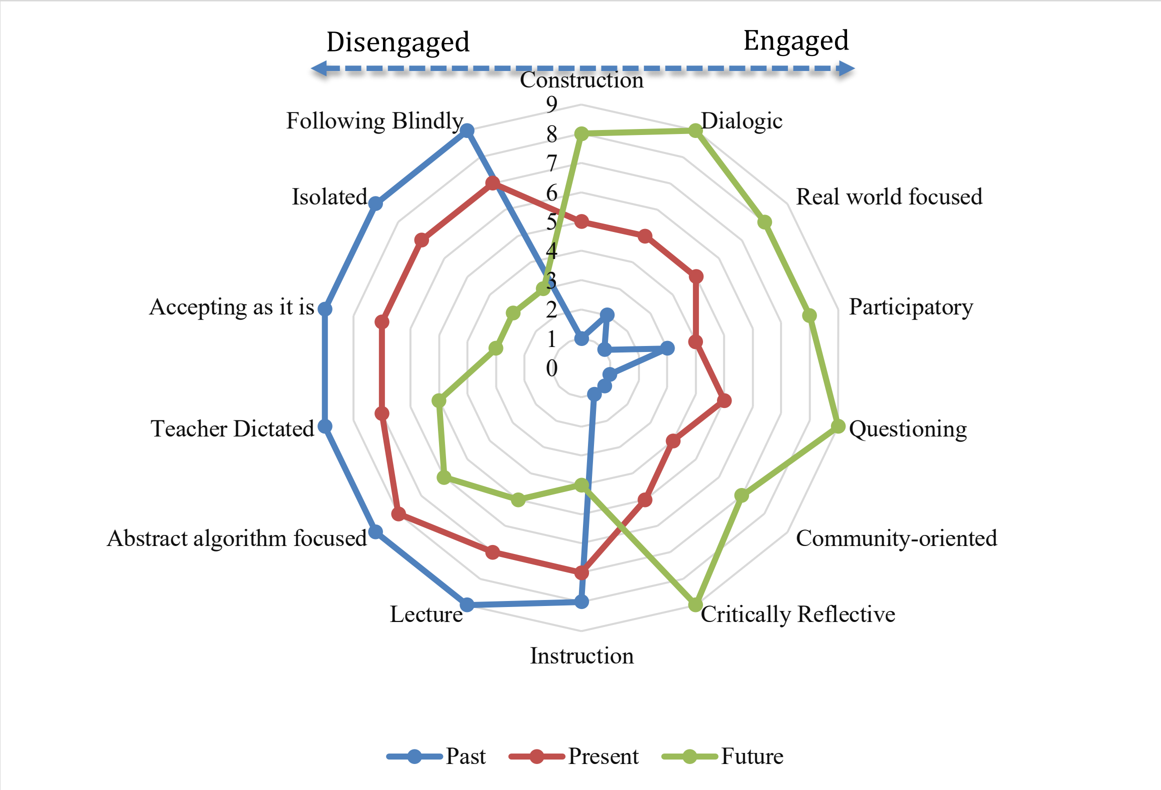
In math class, we do not just memorize patterns,
But, sometimes, memorization is necessary for foundational skills.
We explore and discover critical thinking skills.
But not all students may grasp these concepts equally.
It is not just textbooks and solving algorithms but hands-on learning,
But hands-on activities can be resource-intensive and time-consuming.
Understanding concepts and real-world problem-solving.
But real-world applications might not always align with written tests.
We do not just solve equations on a page,
But some students may still struggle with abstract concepts.
We develop our minds, and critical thinking is all the rage.
But critical thinking can be challenging to assess objectively.
We do not just follow a prescribed path,
But a carefully designed curriculum may ensure the inclusion of essential topics.
Creativity is encouraged, and we make connections that last.
But creativity can sometimes be stifled by a rigid educational system.
In math class, we are active, not passive, it is true,
But not all students thrive in an active learning scenario.
Engaged pedagogy is the way, and innovation is what we do.
But innovation requires continuous adaptation and support.

(Personal Diary, November 2022)

The poem above reflected my future perspectives, offering the invitation to the readers as a proposal for engaged pedagogy in school mathematics. The engaged pedagogy in school mathematics emphasizes the involvement and engagement of students in their learning at the pace, speed, location, and time (Curtis, 2012). This method offers students practical, real-world experiences that are tangible in their understanding of mathematical ideas. It promotes collaboration, critical thinking, and problem-solving in the classroom. The goal of engaged pedagogy in school mathematics is to assist students in gaining a deeper comprehension of mathematical ideas and the ability to use them in practical contexts. Figure 11 shows my past, present and future perspectives of engaged pedagogy in school mathematics based on my engagements as a mathematics teacher, educational researcher, and PhD scholar.

Figure 11

My Past, Present, and Future Perspectives of 'Engaged Pedagogy' in School Mathematics



(Figure generated from field text, 2022)

Figure 11 shows my reflectively generated components of engaged pedagogy (in a dialectical sense co-arising with otherwise conceived opposites such as construction and instruction) in school mathematics across past, present, and future perspectives. My past, represented by the blue line, shows lower values across most axes for the components of disengaged pedagogy including instruction, lecture abstract algorithm teacher-focused, accepting as it is, isolated and following blindly. The zone created by these components may represent a lesser extent of engaged pedagogy. Given my present situation as a teacher educator and interacting with my participants and critical friends offered the impression that there is a visible shift-in-making towards the region of engaged pedagogy while I felt that it is not sufficient to imagine the world with minimal constraints (Habermas, 1972), developing critical consciousness (Freire, 1970), becoming aware of multiple-integral logical possibilities (Mezirow, 1991) and becoming aware of inner, and outer selves (Gandhi, 1909). The future perspective, shown by the green line, displays higher values across all axes of pedagogical approach to construction, dialogic, real-world focused, participatory, questioning, community-oriented, and critically reflective, indicating a vision for the future where engaged pedagogy is highly developed.

Thus, mathematics teachers could create an engaged pedagogy (without rejecting the so-called disengaged pedagogy) that fosters a deeper understanding of mathematical concepts among students by incorporating the above components into their teaching and learning strategies. Likewise, engaged pedagogy in mathematics could generally include a range of components that support student engagement, real-world connections, hands-on learning, community involvement, and continuous evaluation for improvement via fostering their learning engagements.

Swa Inquiry: First-Person Reflections

My journey as a teacher and researcher has shifted from traditional, teacher-centric methods to engaged pedagogy. Through Swa inquiry, I reflect on my experiences, biases, and growth. I questioned why lectures and standardized curricula dominate mathematics instruction, often leaving students passive and disengaged. My understanding of engaged pedagogy has evolved to emphasize student-centered approaches, where teachers and community members act as guides rather than information distributors. This transformation aligns with the Swaraj perspective, which advocates freedom in learning and teaching, challenging conventional perceptions of pedagogy (White, 2018). I have experimented with various strategies, such as home visits, parent-teacher meetings, and guest lectures from parents, to foster deeper connections between students, teachers, and the community. For example, during home visits, I discovered how students' home environments impact their learning, leading me to tailor my teaching methods to their needs. These experiences have reinforced my belief in the importance of active learning and real-world relevance in mathematics education. My reflections highlight the need for a paradigm shift in teaching mathematics, moving from rote memorization to fostering critical thinking, creativity, and problem-solving skills.

Twam Inquiry: Second-Person Relational Reflections

Through Twam inquiry, I engaged with research participants, teachers, students, parents, and community members to understand their perspectives on school-community relationships and pedagogical practices. Interviews and focus groups revealed that engaged pedagogy thrives when schools and communities collaborate. For instance, Aarati, a research participant, emphasized the importance of connecting mathematics to real-life applications, such as calculating interest rates at local banks. Kamal highlighted the role of project-based learning in driving student engagement, while Hari pointed out the challenges posed by parents' expectations for result-oriented instruction.

A critical friend, Naresh, noted that engaged pedagogy enhances student motivation, critical thinking, and problem-solving skills. These interactions underscored the importance of dialogue and co-construction of knowledge in creating meaningful learning experiences. For example, guest lectures from parents allowed students to see the practical applications of mathematics in various professions, fostering a sense of relevance and motivation. Similarly, parent-teacher meetings provided opportunities to discuss students' progress and align teaching strategies with their needs. Thus, engaged pedagogy is not about classroom activities but about building collaborative relationships between schools and communities. Events like Curriculum Eve and math clubs create spaces for teachers, students, and parents to collaborate on learning projects. For example, during a math club session, teachers worked together to solve complex problems, fostering a culture of collaboration and innovation. These practices highlight the importance of community involvement in shaping pedagogical practices and creating a supportive learning environment.

Tat Inquiry: Third-Person ‘Universal’ Insights

I examined the broader contexts that shape engaged pedagogy through Tat inquiry, including institutional policies, cultural norms, and community involvement. In Nepal, the shift toward STEAM-based education has created opportunities for multidisciplinary approaches to mathematics teaching. However, systemic barriers, such as rigid curricula and limited resources, often hinder the implementation of innovative practices. For example, Aarati noted that school administrations sometimes resist innovative approaches, limiting teachers' ability to engage students effectively. Cultural norms also play a significant role. In many communities, mathematics is viewed as a subject for rote learning rather than critical thinking. This perception can discourage students from engaging deeply with the subject. However, initiatives like home visits and community-based projects have shown promise in bridging the gap between schools and communities, fostering a more inclusive and relevant approach to mathematics education.

Likewise, the insights from this inquiry have universal implications for mathematics education. Engaged pedagogy, rooted in transformative learning theory and critical pedagogy, challenges traditional practices by emphasizing student agency, collaboration, and real-world relevance. The Swaraj perspective further highlights the importance of locally relevant education, where communities actively shape pedagogical practices. These insights suggest that schools in Nepal, generally and worldwide, can benefit from fostering stronger relationships with their communities and creating more inclusive and engaging learning environments.

Theoretical Synthesis: Engaged Pedagogy as a Dialectical Space

Drawing from Figure 9, the engaged pedagogy in mathematics education emerges as a dynamic connection of theoretical insights and lived practices. Drawing on Schubert's (1986) metaphor of 'multiple colors, aspects, and dimensions,' this pedagogy resists monolithic approaches, instead embracing a plurality of methods, voices, and contexts. Freire's (1970) vision of education as a process where the 'world becomes the word and vice versa' underlines the necessity of connecting classroom learning to students' lived realities, bridging abstract concepts and community-based applications. Similarly, Habermas (1972) calls for 'uncorrupted power,' and critical self-reflection challenges educators to interrogate their roles in perpetuating or dismantling systemic inequities. The Swaraj perspective explores these ideas, framing pedagogy as a collective endeavor rooted in mutuality and ethical responsibility. This aligns with Mezirow's (2000) transformative learning theory, which positions teachers as facilitators of dilemma resolution, fostering collective growth. These referents advocate for a transformative pedagogy grounded in dialogue, cultural relevance, and critical consciousness. The Swa-Twam-Tat methodological trend reveals the multidimensional nature of engaged pedagogy. Personal reflections highlight the ethical imperative of dharma—teachers' duty to nurture curiosity while navigating institutional constraints. Dialogues with participants reveal the centrality of relational trust, while ethnographic and policy analyses underscore systemic barriers that inhibit innovation. However, localized, culturally responsive practices can subvert these constraints. The study navigates contradictions inherent in shifting paradigms. While engaged pedagogy prioritizes critical thinking and real-world relevance, participants acknowledged the necessity of foundational skills and structured curricula. Creativity and standardization exist in tension, and technology-enabled peer assessments foster collaborative learning but reveal inequities in digital access and evaluative literacy.

Engaged pedagogy redefines the role of communities as active partners. Home visits, parent-led guest lectures, and Curriculum Eve events exemplify Freire's (1970) 'authentic insight,' where knowledge is co-constructed across generations and contexts. Yet, cultural norms and socioeconomic disparities often limit participation, necessitating hybrid models that blend formal meetings with digital engagement. Building on these insights, the proposed framework integrates cognitive-affective balance, community-school synergy, and teacher competencies. While engaged pedagogy offers a path toward democratizing mathematics education, its implementation faces hurdles such as resource and policy gaps, cultural resistance, and the need for sustained professional development. This chapter advances engaged pedagogy as a dialectical space where theory and practice, individuality and collectivity, and tradition and innovation converge.

Chapter Summary

The chapter offers space for engaged pedagogy, which is considered a dialectical space where various logics connect to enhance the educational experience. Dialogic logic bridges hierarchical teacher-student dynamics, fostering a fairer learning environment. Poetic and metaphoric logic re-enchants mathematics, presenting it as a creative and experiential subject. Narrative logic contextualizes learning within community histories and identities, making education more relevant and meaningful. The concepts of Bahuprasnavāda, Bahurūpavāda, and Bahuarthavāda collectively validate multiplicity as essential to knowledge construction. This approach aligns with Prājyanvāda's wisdom, which asserts that education must transcend technical skill-building to nurture critical, empathetic thinkers capable of navigating complexity. Together with these logics, the chapter advocates for a relational pedagogy (Twam), reflective (Swa), and transformative (Tat), rooted in both local realities (Swaraj) and universal ideals of equity. Thus, this chapter has explored the role of school-community relationships in developing engaged pedagogical practices in mathematics. Through Swa, Twam, and Tat inquiries, I have gained a deeper understanding of how personal, relational, and contextual factors shape teaching and learning. Engaged pedagogy, grounded in transformative learning theory, critical pedagogy, and the Swaraj perspective, offers a powerful alternative to traditional methods, fostering critical thinking, creativity, and problem-solving skills. The insights highlight the need for stronger collaboration between schools and communities and systemic changes to support innovative practices. In the next chapter, I will explore how local and global knowledge can be integrated into the mathematics curriculum to produce innovators.

CHAPTER VI
TEACHERS' PROFESSIONAL DEVELOPMENT INITIATIVES AROUND SCHOOL MATHEMATICS

The contemporary view that professional learning must take place with teachers rather than be delivered to teachers but provides an important expansion to current work in this area by arguing that a focus on teachers' learning of new strategies and principles may still fall short of creating long-term change in teachers' professional practice.

(Grimmett, 2014, p. 1)

In Chapter Four, I discussed the need to develop teachers ready to enact dynamic curriculum space, whereas I felt the need to expand my inquiry with a focus on teachers' professional development to address the need for implementing engaged pedagogy. Aligned with Grimmett (2014) for the Swa-Twam-Tat inquiry, although Grimmett brings these texts from a context different from my own, in this chapter, I draw upon my experiences on teachers' professional development initiatives in school mathematics as a student, teacher, teacher trainer, and STEAM scholar to examine the teacher professional development initiatives around school mathematics. This chapter addresses the emerging research question: *In what ways have change-driven teacher professional development initiatives around school mathematics been inclusive to both local and global perspectives?* For this chapter, I have explored based on "Professional Development in School Mathematics, Synergy Between Local and Global Perspectives of PD, Key to Implementing PD: Remixing Education, Professional Development for Educational Change, Reflections on Evolving Vision of Teacher PD, followed by Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections and Tat Inquiry: Third-Person Universal Insights and Reflections" Grounded on the philosophical and theoretical perspectives of transformative learning theory (Mezirow, 1991), Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019). Thus, teacher professional development (TPD) can be approached through three key dimensions of transformative learning theory (Mezirow, 1991): informing, reforming, and transforming. Informing involves teaching teachers and running sessions to enhance their knowledge and skills. Reforming focuses on collaborating with teachers to improve educational practices. Transforming emphasizes critical reflection and other creative methods to foster deeper understanding and innovation. This transformation can be guided by questioning as inquiry, drawing on the perspectives of four key theoreticians. Freire (1970) asks how teachers connect outside and inside the classroom. Habermas (1972) explores how teachers use reflection to develop authentic insight. Mezirow (2000) examines how they integrate differing viewpoints to resolve teacher dilemmas. Swaraj's perspective (Gandhi, 1909) considers how teachers connect these insights with students' selves, taking care of participatory future studies (Ollenburg, 2019).

Professional Development in School Mathematics

As a mathematics teacher, I realized the demanding need for professional development in school mathematics in Nepal. Historically, Nepali education has been influenced by rote learning and a traditional teaching methodology, often neglecting the conceptual understanding of the subject matter (Panthi & Belbase, 2017; Luitel, 2009; Dahal et al., 2019a; Dahal et al., 2019b). There is a pressing need to shift this pedagogy to focus on problem-solving, logical reasoning, and real-world applications (Dahal, 2022b). In recent years, Nepal has made strides towards improving educational quality. However, mathematics teaching often remains ineffective and unengaging (ERO, 2022). Likewise, professional development programs can serve as a tool to bridge this gap, providing teachers with innovative teaching strategies and new technologies (Dahal et al., 2022a; Taylor, 2015) by fostering teachers who need ongoing, targeted training instead of one-off workshops to improve their teaching methods and methodologies. Furthermore, building a community of practice among mathematics teachers can encourage knowledge-sharing and continuous improvement (Allen & Johnston-Wilder, 2003). Thus, envisioning professional development in school mathematics in Nepal involves a multifaceted approach that focuses on updating teaching methods, incorporating technology, and fostering a collaborative learning environment.

In the next section, I attempted to envision the different phases of professional development (PD) by integrating local and global perspectives. This includes a comparison between occasional PD, which tends to be sporadic and event-based, and continuous PD, which is an ongoing process embedded in daily teaching practices. I explore embedded formative PD as a tool that supports teachers in real-time, enhancing their skills through immediate feedback and reflection. Additionally, authentic summative PD is discussed to evaluate long-term professional growth, alongside the role of peer and self-assessment in fostering collaborative and reflective teaching practices. The discussion extends to PD across various educational levels—basic, middle, and high schools—highlighting the need for tailored approaches that meet the unique challenges of each level. Finally, I emphasize the importance of remixing education as a key strategy in implementing effective teacher Professional Development (PD), ensuring that it remains relevant and responsive to the evolving educational reform.

Synergy Between Local and Global Perspectives of PD

As a mathematics teacher educator, I have observed both the challenges and progress in the professional development of teachers in Nepal. Diverse perspectives—from global educational trends to local cultural contexts—influence the current state of teacher professional development in our context. Traditional teaching methods prioritizing rote memorization over conceptual-reflective-critical-imaginative understandings significantly impact Nepali classrooms (Dahal, 2020; Shrestha, 2018). The issue is further worsened by unplanned interventions and reduced investments in empowering teacher training programs (ERO, 2022). In rural areas, challenges include geographical isolation and infrastructural issues, together with the restricted view of teacher training as a transmission of ideas by experts

Conversely, urban schools frequently possess better resources; however, they contend with overcrowded classrooms and a curriculum that may be disconnected from students' lived experiences. Local culture and societal values also have a substantial impact. For instance, hierarchical societal norms may serve as an impediment to open communication between teacher educators and teachers. Consequently, PD programs must be cognizant of these cultural components and promote a pedagogical transition to inquiry-based, student-centric learning. Continuous professional development is prioritized on a global scale, with a focus on implementing a dynamic curriculum and engaged pedagogy. Foreign aid organizations and educational partnerships frequently introduce global perspectives into Nepali educational systems, as illustrated in my problem statement section (see Chapter I, problem statement section).

However, these initiatives must be connected with Nepali contexts to address the requirements of the local community. For example, the global trend toward integrating interdisciplinary teaching and learning design, such as STEAM education, can offer valuable insights for revising the mathematics curriculum of Nepal (Dahal, 2022b). An environment that is enriched for PD can be established by developing a glocal (synergy of local and global) perspective. For instance, a more adaptable and scalable innovation may be achieved through peer mentorship, collaborative research, and digital forums by promoting the exchange of knowledge among teacher educators and teachers, thereby dismantling the silos and divisions that frequently exist in educational environments. The Ministry of Education (2022) has recently released the School Education Sector Plan (SESP), which provides a comprehensive vision for enhancing teacher competencies to revise pedagogical approaches in favor of critical, participatory and constructivist approaches. Nevertheless, the implementation of this initiative continues to be a challenge, necessitating an empowering collaboration among international partners, policymakers, and local communities. I felt that a hybrid glocal perspective is necessary to provide a more empowering, adaptable, and effective approach to the changing landscape of teacher professional development in schools in my context. I believe that the purpose is to establish professional development programs deeply rooted in Nepali culture and reality while simultaneously incorporating universally developed ideas, an approach to developing a dialectical space between contextualism and universalism. Of course, the dialectical space cannot be neutral or value-free. I reflect poetically thus:

Without having a utopia and vision
Can I embrace a change in pedagogical mission?
Without acknowledging my unknowingness
Can I be ready for dialogue with openness?
O Freire, may I develop further without being questioned?

Occasional and Continuous PD

As a mathematics teacher in different phases of my teaching career, I have often found myself at the intersection of traditional and progressive. Like many of my colleagues, I was initially influenced by pedagogy prioritizing rote learning, echoing the teaching styles that have been the backbone of Nepali education for generations (Dahal, 2013; Dahal et al., 2019a). However, the increasing awareness of contemporary educational practices and the government's push for improved pedagogy pressed me to explore alternative approaches in my career as a teacher. The following vignette attempts to reflect such alternative approaches. *It could be any evening in July 2018; I was* *drafting my reflective note on my professional development while serving as mathematics community head. However, during one of the school's transitional phases, I was introduced to the concept of occasional teachers' professional development (PD). The idea seemed simple yet promising: periodic workshops and seminars designed to update us on modern teaching methods, curriculum changes, and classroom management techniques are occasionally conducted every winter vacation. Sensing the winds of change, the school administrator encouraged me and others to attend the workshops whenever possible. First, I went to Ms. Pema's one-day workshop on "Incorporating Real-world Math Problems in the Classroom." My limited experience with such flexible teaching methods made that workshop nothing less than an epiphany for me. In particular, the idea of turning everyday events into math problems that my students could relate to interested me a lot. Following Ms. Pema's workshop, I went back to my classroom, determined to use what I had learned to make a difference and get my students interested in math.*

(Personal Diary, July 2018)

As much as I wanted to implement these innovative teaching methods suggested by Ms. Pema, I grappled with challenges. First and foremost, there was the issue of class size. My classroom was often crowded with more than 30 students, which made it difficult to apply the interactive, real-world problem-solving exercises that seemed so straightforward in the workshop environment. Moreover, I realized that the workshop, although enlightening, had left some gaps. While it provided me with a broad overview, there was no follow-up or sustained support to help me through the intricacies of practical implementation. I had questions that needed answers and problem scenarios that required nuanced solutions—support that a one-off workshop could not offer. Despite these challenges, I was not willing to give up. Initially, I tried to integrate real-world problems such as the climate crisis, the environmental crisis, and the preservation of diversity once a week every Friday, carefully choosing problems that could be managed given the class size and resources. Slowly but surely, I began to see a difference. The students, once passive receptors of information, started becoming more engaged and interactive. As more occasional PD opportunities came along by the school administration—some on technology integration, some on classroom diversity, and others on new teaching methods—I found each experience adding another layer to my teaching experiences. However, the lack of sustained support has remained a constant concern for an enriching praxis of pedagogical innovation. I found some supplementary guidance through online resources and interactions with colleagues who had attended similar workshops.

While reflecting, I see the value in these occasional PD programs. They serve as mechanisms, igniting the trigger for change and innovation in my pedagogy. The efficacy of these programs lies in how well I, as a teacher, can adapt these broad concepts in my unique classroom settings. In an ideal situation, occasional PD would be supplemented by continuous, long-term professional development that allows for mentorship and ongoing support as a learning opportunity for the teachers. However, until that comprehensive model becomes a reality, occasional PD can be a much-needed bridge toward contemporary pedagogy. The workshops may not offer they provide valuable tools to help me navigate the complexities of nurturing 21st-century learners. The conversation surrounding professional development (PD) often centers around two types: occasional PD and continuous PD. Here, I explore the model of continuous and occasional PD, their potential impacts on improving teaching practice, and how they contribute to the being and becoming of mathematics teacher educators.

As per my experience, occasional PD is established in Nepal due to its relative ease of implementation and lower costs (Ministry of Education, 2016). Teachers from both urban and rural regions can attend these workshops and return to their classrooms with fresh insights. For instance, single-session workshops often fail to provide the continuous support necessary for substantial pedagogical transformation. While educators may consider these sessions with renewed enthusiasm, they frequently lack the ongoing mentorship and resources to integrate new instructional strategies effectively. Thus, the absence of follow-up mechanisms complicates the assessment of long-term impacts.

On the other hand, continuous PDs are designed to promote long-term learning, mentoring, and regular feedback. The emphasis is on continually helping teachers adapt and improve their teaching strategies through ongoing support. The continuous model is more appropriate for fostering a deeper understanding of contexts and pedagogical change. It aligns with research that suggests that effective PD is job-embedded, focuses on specific classroom content, and involves teachers in active learning processes. However, continuous PD models are often resource-intensive and may be difficult to implement widely. The Nepali education system faces several challenges, including the culture of transmissive pedagogy and a wide rural-urban divide. Occasional PD can be more easily scaled to reach teachers in remote areas but may not offer the sustained impact needed for lasting change. Given these challenges, a hybrid model of PD might be more appropriate. Occasional workshops can introduce teachers to new methodologies and provide basic orientation. At the same time, follow-up through online resources, mentoring, and community forums can offer the sustained support needed for real change (Sims et al., 2023). This can be particularly effective for mathematics education, where pedagogical techniques need continuous modification. The School Sector Development Plan acknowledges the need for enhanced teacher professional development but falls short in prescribing specific models (Ministry of Education, 2016). Overall, as per my experiences, both occasional and continuous professional development have a role to play. While occasional PD offers the benefit of scale and immediate impact, continuous PD provides the depth and sustainability required for long-term educational improvement in a local context. A hybrid approach that combines both advantages could be a viable strategy for advancing the quality of mathematics teacher education in my professional context. Poetically speaking, I would reflect thus:

Without knowing my own locality
How can I approach universality?
Without knowing my limitations
How can I gauge my possibilities?
O Gandhi, may I grow further without looking within?

Embedded Formative PD

In my journey as a mathematics teacher in a rural-to-urban school in Nepal, one of the challenges has always been bridging the gap between theory and practice, termed praxis (Dahal & Luitel, 2020). The change felt necessary in my early pedagogy, but the 'how' remained vague. That is, until my introduction to Embedded Formative Professional Development (PD), although I did not know its name and features in-depth. Unlike traditional one-off workshops and seminars that are generally "occasional PD," Embedded Formative PD offers something different: integrating professional development into my teaching practice (Hondrich et al., 2015). I learned from periodic workshops and embedded reflection on daily experiences, classroom interactions, peer collaborations, and ongoing mentorship.

When my school, where I was working as a mathematics teacher in 2019, decided to implement this model, although I did not know its name. I was curious and skeptical. The plan was to pair senior teachers with younger or less experienced teachers like me. We were to collaboratively plan lessons, observe each other's teaching, and participate in regular discussions to reflect on and analyze our methods (Hondrich et al., 2015). Professional development has become a consistent, embedded part of our work life rather than an external event that happens a few times a year. During the first few weeks, the change felt uncomfortable. I was not used to someone else watching me teach or critiquing my methods. However, my senior partner, Ms. Shrestha, was skilled at giving constructive feedback. She noticed how my students struggled with learning, even if they could routinely solve equations. She advised integrating more real-world problems, such as the climate crisis, environmental issues, and preservation of diversity, into my lessons to help students see the applicability and relevance of math.

Embedded formative PD is about receiving feedback, self-reflection, and self-assessment (Dahal & Pangeni, 2019). I was encouraged to record my lessons and reflect on them later. This practice was eye-opening, revealing both strengths and weaknesses in my teaching methods that I had not previously noticed. Moreover, our weekly peer discussions have become a treasure for discovering new ideas and strategies. We started to share within our pairs a larger group of teachers in the school. These discussions taught me how to better integrate technology into my lessons, even with limited resources. I also discovered new methods for classroom management and student engagement, which may be useful in a rural setting where students come from diverse socio-economic backgrounds.

While reflecting, I realized that the most valuable aspect of embedded formative PD was the sense of community it fostered among teachers. It created a supportive environment where teachers felt comfortable sharing common challenges and seeking help. This shift was particularly crucial for teaching a subject like mathematics, which students often view as alarming or difficult. The changes in my teaching methods started reflecting on my students' attitudes. They began participating more actively in class, asking questions, and even attempting to solve problems in multiple ways. While it required more consistent effort and openness to continual learning, the learning engagements were much more rewarding and long-lasting. As someone once viewed teaching as a mostly static career, this experience has been performative, philosophical, and artistic transformations (Dahal, 2024b). The model has its challenges, including the need for a more dynamic curriculum and continual administrative support. Yet, it offers a path for professional growth that is intrinsically tied to our daily teaching practice. I can now say that Embedded Formative PD is not just a strategy but a philosophy, one that has changed my understanding of teaching and learning from the inside out. However, this prompted me to reflect poetically this way:

Without examining layered distortions
How can I step toward authentication?
Without unpacking hegemonic real
How can I realize unreal, nonreal, and surreal?
O Habermas, may I be enhanced by limiting within the given frame?

Authentic PD

Before 2023, I served as a mathematics teacher in rural and urban educational institutions for over a decade. Nevertheless, the term "change" can evoke both excitement and apprehension. My pedagogical strategies had seemed consistent for years: lectures, textbooks, and periodic exams, but they were not perfect. I was both curious and optimistic and committed to enhancing student learning outcomes. The primary question I grappled with was how to nurture them effectively by understanding the broader concept of educational transformation.

In this regard, one of the research participants, Hari, observed that 'the mathematics teacher is required to evolve in their role as role models, critical thinkers, motivators, and innovators while revisiting the curriculum for delivering and presenting.' In contrast to the more conventional forms of professional development (PD), such as workshops and training sessions, which can be quite abstract, authentic professional development emphasizes tangible results. Authentic professional development involves continuous, collaborative, and context-specific learning experiences that empower educators to effectively improve their practice. It was intended to assess teaching methods by using authentic student learning measurements and subsequently modifying them to achieve superior educational engagements and results.

Thus, these processes aimed to ensure that my teaching methods were in accordance with the students' success, as demonstrated by their performance in real-world applications of mathematical concepts. Our school (where I worked as a mathematics teacher during 2017-2018) collaborated with the British Council to develop a professional development program that was specifically designed to meet the needs of mathematics teachers and other educators as part of this initiative. This necessitated numerous phases, such as baseline evaluations of student performance, ongoing classroom observations, and subsequent assessments. These observations were not superficial inspections; rather, they were comprehensive analyses that involved the review of student interviews and lessons. The results of these evaluations would be reviewed on a monthly basis by expert facilitators. Initially, the program appeared to be intrusive. The presence of a third-party observer in my classroom, who was meticulously examining every aspect of my teaching, was unsettling. However, I was humbled by the initial round of feedback, which included my students' genuine responses, areas of difficulty, and moments of "aha!". I observed the direct impact of my teaching methods for the first time, free from the biases that had been unintentionally cultivated over the course of my years of experience.

Over the next few months, these evaluations helped me critically reflect on my teaching approach. I shifted the facilitation process to more interactive problem-solving sessions. The change was difficult, especially with the large class sizes and limited resources that are too common in rural Nepali schools. But it was also rewarding. For instance, I remember using real-world problems such as the climate crisis, the environmental crisis, and the preservation of diversity related to surveys on the uses of social media and trying to connect statistical concepts to scenarios that were relevant to my students—seeing their eyes light up as they applied statistical investigation. However, authentic professional development was not just about me; it was a collective process that involved all the teachers. In monthly review meetings, I shared insights, dissected challenges, and collaboratively sought solutions. This form of peer-to-peer learning was invaluable. It cultivated a culture of openness, allowing us to critique and learn from each other's teaching practices.

For instance, at one of these meetings, my friend and I talked about how useful it would be to use technology in math class. Even though we did(not) have a lot of resources, everyone agreed that even simple technologies like calculators and mobile apps could make learning more fun. Thus, for me, the authentic professional development journeys could have changed the way of colleagues are more professional in response to the needs and demands. It has made me think deeply about how I teach, change to meet the needs of my students and work with my colleagues to make us all better. However, the path was hard and required a lot of self-reflection and change, but the results were worth it. I saw that a good judgment of my teaching was my students' authentic progress, a lesson that no traditional workshop could ever impart. As I reflect on the authenticity of my own professional development, I speak this way:

Without examining layered distortions
How can I step toward authentication?
Without unpacking hegemonic real
How can I realize unreal, nonreal, and surreal?
O Habermas, may I be enhanced by limiting within the given frame?

Self-Directed PD

As a mathematics teacher, I started my teaching career in rural and urban areas, even though I have often felt disconnected from the cutting-edge advancements in educational practices. Traditional seminars and workshops for teachers' professional development (PD) usually happen, and their one-size-fits-all approaches rarely suit the unique needs and challenges of teaching in a rural environment. When the idea of "Self-Directed Teachers' Professional Development" was introduced to me by one of the training facilitators in one of the PD sessions of December 2016, it reached a harmonious opportunity for me. Outside experts telling teachers what the "best practices" were replaced by giving teachers the power to become experts on their own practices and dilemmas (Mezirow, 1991). My interest in the idea came from the fact that I would not have to travel to workshops or wait for outside groups to help me grow professionally. To the contrary, it put the responsibility squarely on my shoulders and gave me the freedom to shape my growth according to the needs of my students and myself (Gandhi, 1909).

Thus, I focused on improving student engagement and implementing technology in my classroom. My students often found it difficult to relate mathematics to their daily lives, reducing interest and engagement. On the other hand, although I had just access to a couple of old computers in my school, I was keen to explore how technology could assist in making learning more interactive. To tackle these issues, I began searching for online resources. This included video lectures, articles, and academic papers on effective teaching methodologies. I even participated in online forums and followed educators on social media to stay at to date with modern trends in teaching mathematics. The internet, which I had primarily used for social communication and occasional research, suddenly became a goldmine of learning and professional development.

Applying these newly acquired insights into the classroom was not straightforward. I had to consider the socio-cultural contexts of my students, who were primarily from farming communities and had limited exposure to technology. I began with small steps—integrating storytelling into mathematical concepts, using relatable examples like splitting farmland, measuring crop yields, or calculating the time it takes for water to fill a paddy field. These small changes in my teaching methodology impacted how students interacted during the class. For the technological aspect, I managed to get the school to distribute some time for students in the school's modest computer lab. Though limited, the computers were functional and had internet connectivity. I also used simple software such as GeoGebra and Desmos Calculator to create graphs, solve equations, and even venture into basic coding exercises. This hands-on experience energized the students, and I noticed increased engagement.

Throughout these processes, self-reflection became my powerful tool. I kept a journal, noting what worked well, what did not, and how the students reacted to different teaching methods. This helped me improve my pedagogical approaches and have a running dialogue about my professional growth. However, challenges were ample, from skepticism among colleagues who preferred traditional methods to initial resistance from students unfamiliar with this kind of learning. Yet, the more I improved my teaching and learning methods based on continual self-assessment and student feedback, the more the classroom became an engaging learning environment.

Drawing from my experiences, the self-directed approach became my guiding procedure due to the lack of regular, structured PD opportunities. Of course, external workshops and seminars have their place and value organized by professional communities such as math councils and mathematical societies (to name but a few). However, I have found that nothing quite compares to the tailor-made, highly contextual development that comes from directing my own professional journey. Self-directed teachers' Professional Development has been more than just a process of individual skill enhancement for me. It has been a transformative journey that has changed my teaching philosophy fundamentally and challenged me to be who I am as a mathematics teacher. It is about a mindset, a proactive approach towards growth that uses every resource at my disposal, or simply the wisdom gathered from years of teaching experience. Now, at this stage of my career, I have come to understand that professional development is not something that happens to me, but it is something that I actively participate in, and my self-directed approach to PD has allowed me to build a bridge of development, both for my students and myself. Reflecting on my journey thus far, I speak poetically thus:

Without being aware of plural selves
How can I become an eclecticist?
Without challenging stagnation
How can I move up the mountain?
O Mezirow, may I shift without emerging anew?

Key to Implementing PD: Remixing Education

I remember one of the classes of MEd in STEAM education in 2020 when my senior faculty and I were facilitating the courses “Innovative Pedagogy in STEAM Education” and “Theory and Practice in Education” for future teacher educators of Nepal. One of the modules of the course was “Remixing Education” on “Innovative Pedagogy in STEAM Education.” I was so impressed by facilitating the module with my senior faculty. From that class, I realized that implementing professional development across different educational levels in Nepal requires a blend of traditional and innovation, localized understanding and universal awareness, and theoretical knowledge that gives rise to the practical application of that knowledge. Metaphorically, it is alike; think of it as remixing a song where different instruments represent diverse teaching methodologies, student needs, and resource availability; this is a composite image as I proposed in Chapter Four to demonstrate a dynamic curriculum space. For instance, my research participants and a critical friend also agreed that at the basic level, professional development must prioritize foundational pedagogical skills, including child psychology, classroom management, and engaging teaching methodology and methods, but there were inadequate opportunities for the mathematics teacher to be more professional. However, local wisdom can also be incorporated to make learning culturally contextual with the help of peer support among teachers.

As per my engagement as a mathematics teacher and teacher educator, for middle school, the focus of professional development should evolve to include more subject-specific mastery and technology integration. This is where we bring the 'digital instruments' to our remix, collaborating with the local, provincial, and central governments to offer training on incorporating digital tools like educational software to make lessons more engaging. On-the-job training, short courses, and workshops can be conducted in partnerships with tech companies or educational institutions. Peer review sessions, where teachers observe each other's classes and provide constructive feedback as a learning walk, can offer new perspectives and areas for improvement. At the high school level, professional development becomes significantly more complicated as the academic pressure increases, and the subject matter becomes more specialized. As per engagement, the remix includes more advanced tunes like emotional intelligence training, career guidance, and even university-level subject expertise. Mathematics teachers can be encouraged to attend webinars, participate in international workshops, or even undergo specialized courses to keep up with the evolving curriculum and teaching methods. Teacher exchange programs could offer invaluable global perspectives, contributing to the enrichment of teaching methodologies. Hence, remixing professional development in Nepali educational institutions for mathematics teachers covers a harmonious blend of various approaches, levels, and tools, all aimed at orchestrating an impactful, engaging, and culturally resonant educational experience that requires the synchronization of policymakers, educators, and communities, each contributing their unique notes to create a work of holistic development. Speaking poetically, I would raise questions from the vantage point of the interest the remixing serves.

Without knowing the receiving ends
Can I remix to serve their interest?
Without accessing their meaning systems
Can I fix it from outside?
O Habermas, may I transform others without questioning me?

Professional Development for Educational Change

Each lesson a humble offering, each query a budding flower,
Professional development, the unseen root, empowers them every hour.

Yet not in walls confined, does this growth take wing and soar,
It whispers in the rustling leaves, it is the silent ocean's endless roar.

(Personal Diary, January 2023)

Borrowing the ideas of Kyndt et al. (2016), “the main difference between beginning and more experienced teachers lies not in the type of learning activities they undertake but rather in their attitudes toward learning, their learning outcomes, and how their context influences them.” (p. 114). For instance, Aarati, one of my research participants, added that ‘confidence development is the key driver for mathematics teachers and can be developed after participating in different teacher professional development sessions and activities. Moreover, it added that the interest of the trainees must be valued and aligned with professional development to challenge their traditional ways of teaching mathematics.’ Likewise, in my career, aligned with Kyndt et al. (2016) professional development for educational change, I have attended and conducted more than 200 professional teacher training sessions ranging from pre-primary to university level, from Mechi to Mahakali in Nepal, thereby being critical of my own training and teaching sessions as I find a need to develop further by questioning myself as I indicated <u>in the boxed texts</u>. Among the training, many are for mathematics teachers and later, aspiring STEAM educators. When shifting to the STEAM field, the teacher professional development initiatives in Nepal centered on mathematics need to be foundational, reflective, critical, and imaginative so that they can use and expand the disciplinary boundaries. Thus, professional development is oriented by sustainable, inclusive, and systemic changes that address inequity, foster resilience, and empower communities for long-term well-being, as school mathematics has always been a critical area for STEAM Education. For instance, the recent 2024 results in compulsory mathematics of the Secondary Education Examination (SEE) have faced significant criticism as the pass rate is too low. The Government and other university centers' Teacher Professional Development (TPD) programs, among others, need to align about addressing this problem of

> I look into myself
> for my limitations
> While knowing them, I do not repeat
> Then I become Gandhi!
>
> I ask myself
> for any false consciousness
> to develop authentic insight
> Then I become Habermas!
>
> I ask myself and others
> whether or not the experiences count
> in making myself conscious
> Then I become Freire!
>
> I examine my un/seen assumptions
> Like an iceberg
> I find dilemma and contradictions
> I locate frames evolving and changing me!
> Then I become Mezirow!

underachievement. There have been a lot of changes in the curriculum, but the outcomes are not as expected. Does this mean that PDs are not helping teachers to reflect critically on the failures of student learning?

The Continuing and Professional Education Centre (CPEC) at KUSOED has recently taken the initiative by offering PDs to schoolteachers across Nepal. These initiatives hope to have promoted an environment where problem-solving and interactive learning precede traditional rote learning and contemporary and/or innovative approaches. Given that contemporary pedagogical theories call for a more interactive and student-centered approach to teaching math, this represents a significant challenge for us. Further, the expansion of community-based professional development has also grabbed my attention based on my engagements with some sessions of CPEC. Another fact is that teachers are establishing learning communities initiated by KUSOED Teach for Nepal (to name) and other professional groups and/or institutions in many districts where they can exchange their practices, instructional resources, and methodologies, albeit in an experiential fashion. These grassroots professional development initiatives can significantly improve teaching quality. One of my research participants, Kamal, added that ‘it is time to challenge the linear ways of teaching and learning and also professional development initiatives by changing the teaching roles and responsibilities not as discrete task solvers to more innovators by integrating different subject areas and concepts by having components of reflective practice. Even during the COVID-19 pandemic, I have facilitated over a dozen virtual online sessions with components of activities-based, dialogic, and experiential adult learning with reference to the questions reflected in the <u>adjoining texts</u>. This strategy appears sustainable because it fosters ongoing learning and development among teachers rather than solely depending on outside resources or programs. Thus, professional development in Nepal is a layered and multi-stakeholder approach to teacher development in mathematics. It combines regional, global, and local initiatives to affect significant changes in the classroom. This all-encompassing strategy is encouraging for Nepal’s future mathematics and STEAM education despite the challenges that still exist.

> **Freire**: Did you initiate dialogue with teachers by keeping their dignity at the center?
> **Habermas:** Did you allow participants to reflect critically on your sessions?
> **Mezirow:** Did you value their contradictory experiences?
> **Gandhi:** Did you ask your inner self whether you could train others?

Professional Development across Different Settings

For every setting, high and low,
with questions and curiosity to flow
Has room for teaching seeds to grow.
Oh, let us craft a better way,
By challenging systems and my pathway
Where teachers grow, they do not fade away.

For every setting, high and low,
One sends someone at the thaw,
Has room for teaching seeds to grow.
So, hand in hand, we shall board,
By aiming to embrace a conscious inner glow
Each classroom evolves as educators grow.

(Personal Diary, July 2023)

The poem above attempted to reflect the ever-growing nature of teaching and being professional. For instance, Aarati, one of the research participants, commented that ‘teacher professional development sessions refresh me to reach out to the classroom each day with new thoughts and vibe as a professional.’ Kaiser et al. (2017) stated that “on the one hand, both approaches—cognitive (i.e., designed through normative manner) and situated (i.e., designed based on local needs)—are needed for a comprehensive description of teachers’ professional competencies. Thus, Kaiser et al. (2017) argue that “a comprehensive understanding of teachers' professional competencies requires integrating cognitive approaches (rooted in standardized, normative frameworks) and situated approaches (grounded in context-specific, localized practices). On the other hand, it is shown that both approaches can be integrated in a productive way.” (p. 161). So, teachers' dedication and continuous pursuit of knowledge and improvement, cognitive and situated, regardless of the setting, shall be envisaged. For instance, Santosh, one of the research participants, shared that ‘I have attempted to improve my teaching from traditional to progressive without rejecting the earlier one by integrating day-to-day differentiation pedagogies and activities such as presentations from the students, play-based teaching, field visits for data collection for mathematical activities (to name a few).’ Next, Hari, one of my research participants, spoke that ‘teacher professional initiatives around school mathematics offered a platform to be more critical reflective by integrating innovative approaches in teacher professional development.' Reflecting critically, normative approaches have a tendency to prescribe pedagogies, whereas the situated approaches may be useful to disrupt the unhelpful patterns of prescriptions by embracing critical reflection on pedagogical practices, resolving contradictions, and practicing by self before making it available for others.

> **Freire**: Disrupt normative, if it does not situate teachers and trainers in their immediate worlds.
> **Habermas**: Critically reflect on distortions done by normative approaches.
> **Mezirow**: Focus on actual experience and resolve the contradictions between normativity and situatedness
> **Gandhi:** Self training is the key to train others.

Arriving at this stage, I reflect on the above poem as a tool for envisioning that teaching is aa lifelong journey that contributes to personal growth and the improvement of society for prosperity and welfare as envisioned by the plans and policies (National Planning Commission, 2016). In Nepal, a comprehensive teacher professional development initiative is being implemented across urban and rural schools—both private and public, using a blend of traditional training, digital resources, and peer mentorship to enhance teaching methods, curriculum understanding, and student engagement. But the major concerns are their continuity as the sessions seemingly shifted the informing approach to professional development to possibly reforming and transforming ones. In the next section, I have discussed two cases of professional development initiatives in school mathematics.

Case One: A Traditional Model of Professional Development

For many years, I served as a secondary mathematics teacher before I joined as a university faculty in Nepal, adhering to the traditional teacher professional development model (c.f. largely following what the senior did) that has been practiced for decades. These models were initiated by a training center run by the government of Nepal and/or private institutions. I reflect on the poem in the adjoining box. This model is rooted in a hierarchical educational system, where knowledge and skills were believed to be transferable

> **Un-Freire** – Teach the words without experiencing the world!
> **Un-Habermas** – Explain Habermas' definition of reflection without reflecting on their past and present!
> **Un-Mezirow:** Describe Mezirow without unpacking their assumptions about education and learning!
> **Un-Gandhi:** Preaching the idea of inner without knowing their inside-out!

through a one-way communication process from experts to novice and/or veteran teachers. I have attended some workshops, seminars, and training sessions organized by the Ministry of Education, Science and Technology (MoEST) or various I/NGOs working as a mathematics teacher. The structure of these training programs was almost always the same. Experts or trainers could come in, often prepared with PowerPoint presentations, handouts, and other instructional materials. The agenda usually consisted of an introduction to new curricula, teaching methodologies, or government policies. While these sessions were informative, they were often detached from the realities we faced in our classrooms. They felt more like lectures than interactive training, making it hard to visualize how these new techniques could be implemented in my teaching environment, an oxymoronic approach to teaching Freire, Gandhi, Habermas, and Mezirow as expressed in boxed texts. In these traditional settings, there was little scope for dialogue, questioning, or critical thinking (Dahal, 2017; Dahal et al., 2019a, 2019b; Dahal, 2022b). The trainers presented, and we listened. We took notes and tried to grasp as much as we could, often overwhelmed by the straightforward volume of information. After these sessions, I return to school with a certificate of attendance and an ambiguous sense of learning something new. Yet, applying those newfound concepts practically in the classroom was difficult due to a lack of ongoing support or follow-up. The traditional model also had its limitations in terms of reach and inclusivity.

For those who could attend, the cost of travel and accommodation was a significant barrier in Nepali scenery. The sessions were usually in Nepali or English, which also disconnected those who were more comfortable with their local dialects. However, “teacher professional development is complex and continually evolving, influenced by changes in management theory and educational needs.” (Bodnar & Yuwei, 2024, p. 123). The diversity of Nepal, with its varying educational settings, from well-funded urban schools to resource-poor rural schools, was rarely considered in these traditional programs. Most training courses were generic, meant to serve a "one-size-fits-all" purpose, which was ineffective. There was a gap between the intended policy or teaching method and the ground reality, which these training programs failed to bridge. Moreover, this model was often event-based rather than being a continuous process. Once the TPD workshop or seminar was over, that was until next year, another training session on a new topic would occur. The absence of a feedback loop or a support system meant that the sustainability of any potential improvements was compromised. Many teachers, including myself in those days and even now, felt disconnected and found it challenging to integrate new methodologies into our existing curricula. That is not to say that the traditional model was entirely ineffective. These training programs provided a certain sense of discipline and formality. The centralization of the education system meant that updates to curricula or policy changes were disseminated relatively uniformly. For instance, for those teaching the same way for many years, these training sessions were an opportunity to break the monotony and gain exposure to new teaching aids or methods, even if they were not immediately applicable. Still, I often found myself wishing for more. I wanted a professional development program that was more aligned with my day-to-day challenges and issues, one that encouraged active participation.

I was seeking training with the hope of taking into account the issues and challenges I encountered while teaching and learning mathematics and fostering a sense of community among teachers rather than a hierarchical divide. But it was a tough job for me. Yet, as the years have passed, the limitations have become increasingly obvious. The educational model of mathematics teaching has changed, and we, as teachers, must evolve, too. Therefore, the request for a more continuous, participatory, context-responsive, and inclusive teacher professional development model (Dhungana, 2022a) is growing forceful, pushing to question, innovate, and, most importantly, learn by engaging even in the training session.

Context Two: Potentially A Contemporary Model of TPD

I remember teaching in Nepali schools during my early career in 2010. The teaching procedures were like a rigid and unchanging profession. The headteacher does not care about professional development, and the job description is simple: follow the prescribed textbooks, complete the syllabus, and prepare students for exams. However, in recent times, the educational scenario has evolved differently. Being a mathematics teacher is not only about following the prescribed textbooks and completing the syllabus, but also about developing professional development to meet the ever-changing needs of the students and the glocal surroundings in which they will eventually work. So, change-oriented teaching and learning are common needs in how we teach and grow as educators. This approach does not solely focus on a one-time training seminar or a series of disconnected workshops. Instead, it proposes a continuous, cyclical process of learning and improvement that is far more dynamic and responsive. Unlike traditional teacher development programs that are often overly theoretical, this approach connects the dots of real-world classroom experiences and encourages active participation from teachers. One of the foundations of this initiative is its inclusive approach. The rich diversity marks Nepal: educational quality varies widely and is heavily influenced by available resources.

> *It could be any early cool morning of the day of March 2021; I was invited to facilitate the virtual teacher professional development session at Ramechhap from Kathmandu Valley. The theme of the session was "ICT tools for remote teaching and learning". With all the logistical management, I started the session with the consent of the organizer. I welcomed all the participants who were public-school teachers. With a welcome, I started the session with the initial virtual activity of "let's know each other" on the Padlet platform. All the teachers responded on the platform. In a quick reaction, one of the make teachers shared, "This is fascinating for me. I learned how to introduce myself and know others." I attempted to engage all the teachers throughout the session. Toward the end, I thank all the teachers for their active engagement during the sessions and the organizer for the arrangement.*
>
> (Personal Diary, March 2021)

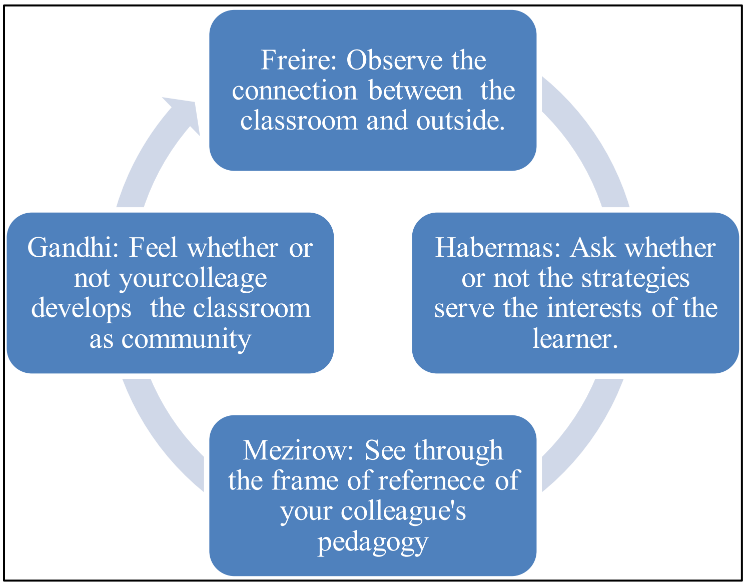
This approach is envisioned to be adaptable across different settings. Traditional face-to-face training is supplemented with digital resources, allowing even teachers from the most remote areas to participate and be part of the community for learning. It is suggested that local teacher networks be set up to encourage peer mentorship and the sharing of best practices. It feels like the playing field is being leveled for the first time. The approaches also emphasize subject-specific training, something that was sorely lacking in earlier initiatives. As a math teacher, I integrate technology and hands-on activities effectively while connecting my training experience that is adapted to teaching mathematical concepts. One of the most innovative aspects of this initiative is the focus on student-centered learning that encourages the shift away from rote memorization and lecture-driven lessons towards a more interactive classroom where students engage in problem-solving and collaborative projects. Continuous assessment of student performance and feedback mechanisms is integral to this approach. Now, the scenario has been changing, and the teachers are not just teaching for exams, but they are teaching for holistic development.

Case Three: An Existing Schools' Transition to Regular TPD

In general, mathematics teachers were given the curriculum, textbooks, and an academic calendar, and mathematics teachers did their best to pack as much information into the students' heads before the exam period arrived. Mathematics teachers had their hearts in the right place, but lacked the continuous professional development programs to transform our classrooms into dynamic learning environments. There is a need for mathematics teachers who could be forward-thinking individuals who can shift the school's culture, curriculum, and overall learning experiences.

With the above, *I can remember one of the events of the year 2018, when a new principal was appointed in the school, where I worked as a secondary mathematics teacher and community facilitator of the school's mathematics. The principal was a forward-thinking individual who had the caliber for shifting the school's culture, curriculum, and overall learning experiences. When the principal announced his commitment to changing the school's culture, curriculum, and overall learning experiences,* I remembered the initial announcement and the buzz it created in the teachers' chamber. There was a mix of excitement and skepticism, even for me. On the one hand, this was the training and guidance many of us at school secretly yearned for; on the other, we questioned its practicality given our already tight schedules and limited resources. Would this even work? And more importantly, how would it affect our teaching methods that have been rooted in years of tradition? Our first encounter with regular professional development was a day-long workshop facilitated by a 'trained' educational expert from the curriculum development center. The setting was different from the traditional, one-off training sessions we had previously attended. This workshop was just the beginning of a long-term process that would involve regular follow-ups, peer evaluations, and self-assessments. We discussed student-centered teaching methods, contemporary approaches to classroom management, and integrating technology into our lessons. In the weeks that followed, we began to implement what we had learned. This was a challenge but also a rewarding experience. We stumbled and struggled, often resorting to our old ways, but the monthly follow-up sessions acted as checkpoints to review our progress and recalibrate our approaches. Slowly but surely, our classroom changing aspects began to change.

With continuous engagement in the sessions, my lessons became more interactive, students took part more, and I felt more empowered and engaged as a teacher, with similar thoughts as depicted in the adjoining figure as I reflected on the process. A key element of this transition was the peer observation and mentorship component. We and other teachers were divided into small groups to observe each other's teaching methods during learning walks, followed by providing constructive feedback. It was an eye-opening experience to see how my colleagues handled their classrooms, and it was even more enlightening to receive feedback on my techniques. Suddenly, teaching was not a solitary endeavor but a collaborative pursuit of educational excellence. The professional development program also included specialized training changed to the subjects—mathematics and science (lower classes) I taught. As a mathematics teacher, I received resources and training on how to make mathematics teaching more practical and engaging. Simple but impactful methods like integrating field visits and conducting basic experiments turned previously abstract concepts into tangible learning experiences for my students. The school management was helpful in this transition. The principal allocated a budget specifically for training materials, guest speakers, and additional resources. This financial support was crucial in allowing my colleagues and me to participate fully in the professional development process. Furthermore, I began involving parents in this transition, updating them through meetings and newsletters about the changes they could expect in teaching methods and classroom environments. I have also written about some events in the school's regular newsletter that I have conducted in the different classes. As I had to juggle my regular teaching responsibilities with ongoing training sessions, there were some challenges, such as time. Some teachers found it difficult to adapt to new methods, questioning the necessity of such a shift after years of teaching a certain way. However, as I began to see tangible outcomes—improved



student participation, enhanced engagement, and positive feedback from parents—even the skeptics among teachers started to recognize the value of regular professional development. Two years into this initiative, by 2020, the school had become one of the top schools in Nepal. I can sense the change the moment I walk into a classroom: students are more engaged, teachers are more passionate, and there is an intense energy that was not there before. Test scores have improved, but what is even more important is that the students are developing a legitimate learning experience for change. They ask questions, collaborate on projects, and display levels of creativity I had not seen before. Looking back, transitioning to regular teacher professional development was a risk, but it has paid off in ways we could not have imagined. It has improved the quality of education I provide and elevated my status as an educator. Thus, I transitioned from merely transmitting knowledge to becoming a learning facilitator, continually evolving in our quest to shape the students' future. And this journey of transformation continues with more questions as in the boxed texts!

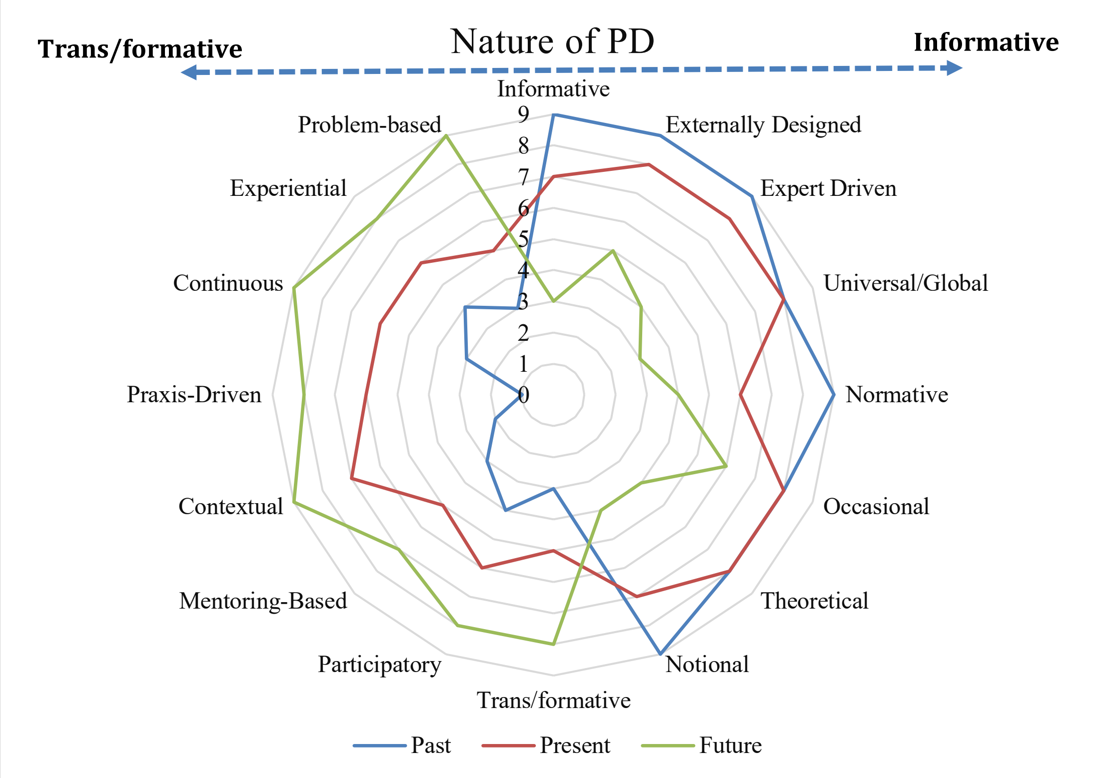
> *Freire me*: How am I disrupting the idea of mathematics being separate from the world?
>
> *Habermas me*: In what ways am I challenging dogmas and enslavement of TPD as external imposition?
>
> *Mezirow me:* What it takes for me to challenge myself and others to unpack our assumptions that hinder growth?
>
> *Gandhi me:* How does this journey help me to actively listen to the inner world and connect with the community?

Reflections on the Evolving Vision of Teacher PD

As I sit in my classroom after another engaging professional development session, I find myself reflecting on the impact these initiatives have had on my career from 2018 to now. Whether through the traditional one-off training seminars or the more modern, continuous programs, the development of teacher professional development in Nepal has been nothing short of transformative. When I first started teaching, I perceived professional development as an occasional event—something to endure for certification. It was a few days spent listening to experts and trainers talk about theories and methods that seemed distant from the classroom realities I faced daily. Fast forward to today, and I see dramatically different scenery. Professional development is no longer an offshoot event but a core element of educational practice, embedded into my routine, shaping how I teach, learn, and grow as an educator. I cannot help but feel the sensation of how the shift towards regular, ongoing professional development has regenerated mathematics and other teaching communities. A spirit of collaboration has replaced the sense of isolation that often comes with teaching and shared learning. The peer observations, mentoring, and interactive workshops have created a supportive network that allows me and others to survive the challenges of modern-day teaching and thrive amidst them. This collaborative culture has made me more receptive to feedback and more proactive in seeking opportunities to learn and improve. Moreover, the new approaches to professional development have been decisive in bridging the gaps between urban and rural educational settings. With the inclusion of digital resources and online training modules, teachers in the remotest regions of Nepal are gaining access to quality training opportunities. I find it empowering that I and other mathematics teachers are moving toward an equal opportunity for educational engagements where every teacher, regardless of their location or background, can aspire to the same standard of excellence for subject-specific to general training, which has been another milestone. One thing is understanding the learning theories underpinning my different teaching and learning approaches. As an outcome, I am no longer just cramming information into young minds but my critical role in fostering a culture of inquiry and critical thinking. However, it is crucial to acknowledge that while strides have been made, I am still in a transitional phase. There is room for improvement, particularly in tailoring my fostering skills to meet integral aspects of teaching and learning mathematics. Thus, teacher professional development in Nepal has been a journey from passive reception to active participation, from isolated instruction to collaborative learning, and from generalist approaches to specialized training. Figure 12 below shows my vision of teacher professional development in school mathematics based on my engagements as a mathematics teacher, educational researcher, and PhD scholar.

Figure 12

My Evolving Vision of the Teacher Professional Development



(Figure generated from field text, 2022)

Figure 12 shows my reflectively generated components of teacher professional development (in a dialectical sense co-arising with otherwise conceived opposites, such as mapped on a continuum from informative to transformative) in school mathematics across three phases—past (blue), present (red), and future (green).

My past, represented by the blue line, shows lower values across most axes for the components of the informative nature of PD, including informative, externally designed, expert-driven, universal/global, normative, occasional, theoretical, and notional. So, the zone created by these components may represent a lesser extent of the professional development process. Given my present situation as a teacher educator and interacting with my participants and critical friends, it offered the impression that there is a visible shift towards the role of teacher professional development. Thus, for me, the informative journey of professional development involves individuals continually acquiring new knowledge, refining skills, and adapting strategies through structured learning, ensuring they remain competent and responsive to the demands of their professions.

Drawing from above, Mezirow (1991) posits that transformative learning involves a fundamental shift in worldview through critical reflection and discourse. My past PD was primarily informative, theoretical, and externally designed, echoing a transmission learning model. However, the present PD shows slight movement toward reflection and engagement (e.g., experiential and contextual), though it still retains normative and externally driven elements. So, future PD shall align with Mezirow's vision, which is high in problem-based, praxis-driven, contextual, and participatory aspects. These encourage critical reflection, learner autonomy, and worldview transformation. Likewise, Freire (1970) emphasized dialogical, problem-posing educational engagement that empowers learners to challenge oppression and become change agents. My past PD was banking-model-oriented, with teachers as passive recipients. My present PD begins to include participatory and mentoring-based elements but remains partly top-down. Thus, future PD shall align with Freire's (1970) ideals by embracing dialogue (i.e., participatory), experience (i.e., experiential), and problem-solving, suggesting a democratic and emancipatory vision of teacher learning. Habermas (1972) identified three knowledge types: technical, practical, and emancipatory. My past PD served technical interest and focused on control and efficiency (e.g., normative, expert-driven). My present PD introduces the practical interest of interpersonal understanding (mentoring, experiential). Future PD shall embody the emancipatory interest—self-reflection and autonomy (praxis-driven, contextual, participatory), suggesting an evolving understanding of knowledge as socially constructed and liberatory. Gandhi (1909) emphasizes self-rule, autonomy, and indigenous knowledge and practices. Drawing from the Swaraj Perspective Gandhi (1909), my past PD reflects colonial residue—universal/global and externally designed. My presentation shows a gradual de-centering of external authority. So, the future shall be consistent with Swaraj for localized (contextual), autonomous (participatory, mentoring-based), and experiential reclaiming of teacher agency and local epistemologies. On top of the above, Ollenburg (2019) participatory futures approach involves inclusive, imaginative co-creation of desired futures, emphasizing agency and collaboration. Aligned with Ollenburg's (2019) participatory futures approach, my past lacks participatory features and focuses on externally imposed visions. Presentation stars include elements of co-design. The future shall embrace PD's participatory futures that become co-constructed, vision-oriented, and reflective of diverse stakeholder voices.

Figure 12 reflects a philosophical and practical shift from informative to transformative, externally imposed to locally contextualized, passive reception to active, critical engagement, and universal prescriptions to situated, participatory design. Thus, the evolving vision of my teacher professional development in school mathematics aligns with transformative, critical, emancipatory, and participatory. It calls for educational institutions to redesign PD not just as skill transmission but as a collaborative journey toward liberation, relevance, and reflective practice for future teachers. So, the future perspective, shown by the green line, displays higher values across all axes of trans/formative nature of professional development, including participatory, mentoring-based, contextual, praxis-driven, continuous, experiential and problem-based, indicating a vision for the future where the trans/formative nature of professional development for the school is developed. On the whole, the transformative nature of professional development for me and others is an ongoing journey that empowers educators to continually refine their instructional practices, adopt innovative approaches, and shift mindsets, fostering personal growth and collective progress to enhance student learning and enrich the broader educational community.

Thus, as a mathematics teacher who has experienced this transformation first-hand, I can exclaim that these initiatives have reignited my passion for teaching and reaffirmed my faith on a promising path, and I look forward with great anticipation to what the future holds in the different phases of the transformative journeys as my poetic selves speak this way at this stage:

Without looking into my inner mirrors
Without using my eyes as discerners
How can I see the dust and dirt here and there?
Without seeing the unseen, the absence and the hidden
Without realizing the conflict between heart and mind
How can I weave feeling and thinking?
O activist-philosophers, may I move further without conscious walking?

Swa Inquiry: First-Person Reflections

Reflecting on my journey as a mathematics teacher and educator in Nepal, I recognize the significant impact of teacher professional development (PD). Each lesson taught, and every training session attended or facilitated, has contributed modestly yet meaningfully to my growth. Over time, I have come to see professional development as a continuous and evolving process that shapes my identity and trajectory as an educator rather than as a series of isolated events. During the early stages of my teaching career, I relied on conventional methods, including rote memorization, lecture-centric teaching, and strict adherence to the textbook. Historically, professional development was infrequent, typically taking the form of workshops or seminars that provided certificates but lacked substantial practical guidance. I often left these sessions feeling overwhelmed by the wealth of information and uncertain about how to apply it in my classroom. Gradually, I became aware of the limitations of this traditional approach. I began to seek a model of professional development that was participatory, context-responsive, and closely aligned with the realities of my classroom. My perspective shifted when I was introduced to embedded formative professional development. This approach integrates professional development into everyday teaching practices and transforms my approach to work.

Through peer observations, reflective journals, and collaborative discussions, I came to view teaching as a communal journey rather than a solitary endeavor. I developed the ability to accept feedback, critically evaluate my methods, and adjust my teaching to meet the diverse needs of my students. Although this process was challenging—it required vulnerability and a willingness to change—it proved to be rewarding. My students demonstrated increased engagement, curiosity, and confidence in their abilities. As I progress in my role as an educator, I recognize that professional development is a lifelong journey rather than a final destination. It is an ongoing process characterized by efforts to enhance, innovate, and inspire. I value the opportunities to learn from my peers, students, and the international community of educators. These experiences have significantly influenced my development as an educator and will continue to guide me through future challenges and opportunities.

Twam Inquiry: Second-Person Relational Reflections

Reflect on your experiences in the Twam inquiry as a mathematics instructor and educator, considering the impact of professional development on your teaching methods. Recall the early stages of your career when you primarily relied on traditional pedagogical approaches. What were your impressions of the workshops and seminars you attended? Did they provide the necessary support and guidance for your success in the classroom? Consider the transformation you underwent when you were introduced to embedded formative professional development. How did this model change your teaching approach? What insights have you gained from your colleagues, students, and your own reflections? How did these experiences contribute to your growth as an educator? It is important to note that professional development is more than just acquiring new skills or knowledge. It focuses on building relationships—with students, colleagues, and oneself. The goal is to foster a community of learners that provides mutual support and motivation. How have these relationships influenced your teaching practices? How have they helped you tackle the challenges and opportunities in your profession? Looking forward, what do you envision for your future professional development and that of your peers? What strategies can be employed to encourage growth, innovation, and inspiration in education? How can we improve the inclusivity, engagement, and contextual relevance of professional development models in Nepal?

Tat Inquiry: Third-Person 'Universal' Insights

Teacher professional development (PD) is essential to educational reform, especially in Nepal, where challenges like limited resources, cultural differences, and remote locations can be significant. Professional development for educators involves more than just gaining new knowledge or skills; it also requires changing teaching methods, fostering collaboration, and nurturing a passion for learning. The traditional PD model in Nepal, which relies on hierarchical information transfer and one-time workshops, has struggled to address the complex realities faced in mathematics classrooms. While these sessions can be beneficial, they often lack the context and follow-up for a lasting impact. As a result, many educators find it challenging to integrate new methodologies into their lessons, creating a gap between policy and practice. Fortunately, PD is becoming more dynamic and accessible through new initiatives like community-based learning networks and embedded formative professional development. These models encourage educators to learn from each other and adapt their strategies to meet the specific needs of their students by promoting cooperation, reflection, and flexibility. These programs empower teachers with agency and ownership by embedding professional development into their daily routines, enabling mathematics teachers to engage actively in their own growth. The role of technology in PD is also critical. Digital resources and online platforms can provide teachers in both urban and rural areas with access to high-quality training and materials, regardless of their location. However, the digital divide remains a significant concern, especially in remote regions lacking infrastructure and internet connectivity. To address this issue, a PD model that combines digital resources with traditional in-person training might prove to be more scalable and sustainable. Ultimately, the success of PD initiatives depends on math teachers' ability to adapt to Nepal's unique cultural, geographic, and economic contexts. Thus, national and international stakeholders, by prioritizing the needs and voices of teachers and fostering collaboration among locals, these initiatives can enhance equity and accessibility in the educational system.

This approach offers the foundation for educators with the resources necessary to inspire the next generation of learners, improving opportunities for both Nepal and the world. Overall, professional development for teachers is not just a school requirement but a national obligation. It is an investment in the future that empowers educators to transform their students' lives. Given Nepal's substantial challenges and immense growth potential, PD must be addressed with careful consideration, creativity, and a comprehensive strategy that embraces technology and promotes collaboration by valuing teachers' voices. This approach can develop a generation of educators who are skilled, experienced, motivated, reflective, and dedicated to lifelong learning.

Reflections

Professional development (PD) for teachers is focused on improving educational outcomes and fostering innovative practices in school mathematics. This discussion examines various models and approaches to teachers' professional development (PD) grounded on the lens of transformative learning theory (Mezirow, 1991), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019). Mezirow's transformative learning theory provides a framework for understanding how teachers can critically reflect on their experiences and assumptions to facilitate meaningful change in their teaching practices (Mezirow, 1991) that emphasizes the importance of reflection and discourse in fostering deep, structural changes in the ways teachers understand their roles and the subjects they teach. For the reflective and discourse-oriented PD, I have discussed the contextualizing PD models and continuous and embedded PD. Contextualizing PD models are traditional models of PD that often involve top-down approaches that may not engage teachers in critical reflection or transformative processes. In contrast, a new approach of TPD that encourages reflective practice can align with transformative learning by enabling teachers to question and reformulate their instructional strategies based on reflective dialogue and critical assessment. Next, continuous and embedded PD is considered a shift towards continuous and embedded PD, where learning opportunities are integrated into the daily teaching activities, allowing for ongoing reflection and discourse.

Gandhi's approach in Swaraj critiques modern civilization's reliance on materialism and advocates self-sufficiency and moral integrity (Gandhi, 1909). Applying this perspective to TPD involves focusing on (1) local and global perspectives in PD and (2) self-directed PD and peer assessment. Local and global perspectives in PD attempt to integrate local knowledge systems and values with global educational practices that can create a balanced approach that respects local educational contexts while incorporating global best practices. Self-directed PD and peer assessment, Gandhi's emphasis on self-regulation and community involvement resonates with self-directed PD and peer assessment, promoting a community of practice among self-reliant and collaborative teachers. Participatory future studies, as described by Ollenburg (2019), emphasize the active involvement of stakeholders in designing their futures. In the context of TPD, this approach suggests envisioning PD in school mathematics and authentic and formative PD. Envisioning PD in school mathematics engages teachers in envisioning and designing their professional growth paths. It allows them to adapt PD activities to meet their specific needs and the needs of their students, fostering a more relevant and impactful development experience. Authentic and formative PD supports the creation of authentic PD programs situated in real-world teaching contexts and formative, allowing for ongoing feedback and adjustments based on teacher and student feedback.

So, implementing transformative, community-oriented, and future-driven PD requires a synthesis of these theoretical perspectives to suggest a transformative, community-oriented, change-driven model of PD. Such a model would feature embedded formative PD and authentic PD. Integrating regular feedback mechanisms within PD activities to allow for continuous learning and adaptation. Likewise, authentic PD is aligned with the designing summative PD activities that not only assess the effectiveness of PD but also celebrate the transformative journeys of teachers by offering opportunities for remixing education leveraging insights from transformative learning, Swaraj, and participatory future studies for remixing traditional educational practices with innovative, contextually relevant approaches that empower teachers.

Through the lenses of transformative learning, Swaraj, and participatory future studies, PD offers a rich, multidimensional approach that can significantly enhance the effectiveness and relevance of professional development in school mathematics. These approaches are the shift from discontinuous, one-size-fits-all PD to a more personalized, continuous, and reflective practice that prepares teachers to adapt to current educational challenges and actively shape the future of education in their contexts. Thus, PD in school mathematics of Nepal is unfolded in three dimensions—informing, reforming, and transforming. Each dimension contributes to a holistic approach that bridges local realities with global pedagogical insights. Thus, grounded in transformative learning theory (Mezirow, 1991; 2000), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019), these referents and perspectives foster inclusive, context-responsive growth for educators. Informing focuses on equipping teachers with foundational knowledge through workshops, seminars, and training sessions. Different agencies in Nepal, such as the Ministry of Education, initiate the PD and rely on hierarchical, one-way knowledge transfer. While these sessions introduced new curricula or technologies, they often lacked interactivity and contextual relevance. For instance, Aarati, a teacher participant, noted that while such sessions sparked ideas, their generic nature made classroom application challenging. The COVID-19 pandemic underlined the potential of virtual platforms, enabling over a dozen online sessions that reached remote educators. However, limitations like language barriers and resource disparities featured the need for more adaptive, localized approaches. Reforming shifts from passive reception to active collaboration, emphasizing peer mentorship, community-based learning, and iterative feedback. Initiatives like KUSOED's CPEC programs and teacher-led learning communities exemplify this dimension. Peer observations and reflective journals, as experienced by teachers in Ramechhap, fostered a culture of shared growth. Kamal, a participant, advocated for moving beyond 'discrete task-solving' to interdisciplinary innovation. These efforts align with Habermas' emphasis on reflection for authentic insight, where dialogue and collaboration dismantle hierarchical divides, enabling educators to co-create solutions tailored to their classrooms. However, challenges persist, such as balancing training with teaching responsibilities and addressing skepticism among teachers. Transforming transcends technical skills, urging educators to critically interrogate their practices through equity, creativity, and self-awareness lenses. Here, four guiding questions from four different theorists shape inquiry: Freire (1970): How do teachers connect classroom learning to students' lived realities? Initiatives integrating real-world problems (e.g., climate crises) into math lessons exemplify this, fostering relevance and engagement. Habermas (1972): How does reflection cultivate authentic pedagogical insight? With peer feedback and self-assessment, embedded formative PD nurtures continuous, context-responsive adaptation. Mezirow (1991): How can differing viewpoints resolve teaching dilemmas? Collaborative forums and blended learning models encourage integrating diverse perspectives, essential in socio-culturally diverse classrooms. Swaraj's perspective (Gandhi, 1909): How are insights connected to students' selves? Featuring self-reliance and moral integrity, the Swaraj perspective urges educators to align teaching with students' identities and aspirations, as seen in community-driven STEAM initiatives. Likewise, participatory future studies (Ollenburg, 2019) further enrich this dimension by engaging teachers in envisioning adaptive, equitable futures. For instance, integrating digital platforms like GeoGebra democratizes access to interactive tools, while local networks blend global trends with indigenous knowledge. So, effective PD demands a remix of informing, reforming, and transforming. While traditional workshops lay the groundwork, collaborative praxis and critical reflection ensure sustained innovation. These changes from occasional PD to embedded, formative models—supported by peer networks and technology—illustrate this evolution. As Santosh, a teacher and a participant, reflected, transitioning from rote methods to student-centered approaches required 'continuous unlearning and relearning,' a journey mirrored in broader educational reforms. Thus, PD must honor the cultural and geographic diversity of Nepal while embracing global best practices so as to foster communities of reflective practitioners grounded in Freirean dialogue, Habermasian reflection, Mezirowian integration, and Gandhian self-reliance. Educators of Nepal can transform classrooms into spaces of empowerment, creativity, and inclusive growth. 'Each lesson a humble offering, each query a budding flower,' as the poet-educator writes—this ethos encapsulates the transformative potential of PD when rooted in equity, collaboration, and critical hope.

Chapter Summary

For this inquiry, in this chapter, I have attempted to unfold my multifaceted background as a student, teacher, teacher trainer, and STEAM scholar to explore the inclusivity of teacher professional development (PD) initiatives in school mathematics, addressing how these initiatives integrate both local and global perspectives. The analysis is anchored in transformative learning theory, the Swaraj perspective, and participatory future studies, providing a strong theoretical framework. The chapter thoroughly examines different models of PD, including traditional, new, and transitional approaches within schools, emphasizing the shift towards continuous, embedded formative, and authentically summative professional development, highlighting the significance of occasional versus continuous PD, and explores the roles of peer and self-assessment, as well as self-directed PD, in fostering an inclusive and effective environment for teacher growth in school mathematics.

CHAPTER VII
SCHOOL MATHEMATICS TEACHERS' LEADERSHIP DEVELOPMENT PROCESSES AS A REFLECTIVE TEACHER LEADER

In the staffroom, mathematics teachers are planning, planning and preparing are blooming and igniting minds. Leadership grows like roots seeking light.

(Personal Diary, May 2023)

This chapter is drawn by reflecting on my leadership role as a reflective leader within the context of school mathematics, which was influenced by the overall achievements of the students and the school. The foundation of this chapter is that I have reflected briefly on my leadership development process in Chapter I under the subheading "Community Facilitator: Nurturing Leadership Development Process." In this chapter, I unfold the narratives based on my leadership role and leadership development processes as a mathematics teacher, educator, and researcher, as a reflective leader aligned with my research participants and critical friend. These narratives encompass from earlier careers and then mid-career to the researcher based on "A New Beginning as a Full-Time Mathematics Teacher, Becoming a Community Facilitator of Mathematics, Immersing in the Leadership Development Process, Leadership Development Process in Mathematics Education, Moving Forward with Leadership Development Process in Mathematics Education, Concluding Thoughts and Evolving Vision of the Leadership Development Process, Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections, Tat Inquiry: Third-Person Universal Insights and Reflections." Underpinned on the theoretical referents and/or perspectives of transformative learning theory (Mezirow, 1991), critical pedagogy (Freire, 1970), Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019), this chapter is framed with the emerging research question—*how has the leadership development process (teacher as a change agent and reflective teacher leader) been in place in areas of school mathematics education?* Drawing from the above orientation, I begin the chapter by writing a letter to Freire (1970), Habermas (1972), Mezirow (1991), and Gandhi (1909) with different perspectives, viewpoints, and theoretical grounds as a reflective teacher leader.

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Dear Freire,

I am writing this letter to you based on your work, critical pedagogy. Your vision of critical pedagogy, rooted in dialogue and conscientization, resonates with my journey as a mathematics teacher, community facilitator, and educational researcher. For your reading, I have connected your ideas of informing teachers, reforming practices, and transforming educational engagement.

Box poetic in mind, informing teacher roles as a banking model, I conducted a considerable number of workshops before and during my PhD that connect classroom mathematics to real-world contexts with students. These workshops explore geometric patterns in Nepali art or discuss the contributions of local mathematicians. These sessions aim to dismantle the 'banking model' by positioning students as co-investigators of knowledge. Reforming practices enacted with collaboration, as collaboration has been key. When participants like Aarati and Kamal struggled with traditional methods, we co-created lesson plans that blended global pedagogies with local needs, fostering a culture of mutual inquiry. In this situation, the question, "How do teachers connect outside and inside the classroom?" guided me to bridge concepts with learners' lived realities, such as using community challenges to teach problem-solving. Likewise, transforming education offers the critical dimension of critical reflection as an essential engagement. I shifted from rote instruction to participatory learning, initiated by my research participants—Hari and Santosh, to question systemic inequities (e.g., 'victim-blaming' cultures). So, your work on critical pedagogy and dialogue has shaped my approach. In my classroom, I attempt to connect abstract mathematical concepts with students lived realities, such as using geometric patterns in Nepali art to teach symmetry.

> Your words lit up the classroom,
> Where students see math in real life.
> Workshops mixed art with deep patterns,
> And co-learning woke up sleepy minds.
> With bold actions, we challenge norms
> Creating new math based on real experiences.
> But systems push back—can we still dream?
> To teach, to free, to connect the gaps.

However, I grapple with sustaining this connection systematically. How might educators rooted in your principles foster conscientização while navigating institutional constraints like standardized curricula and assessment? For instance, when I integrated local knowledge into lessons, students were engaged, but systemic pressures often prioritized exam outcomes over critical thinking. How can teachers balance emancipatory dialogue with structural realities to truly unite the 'outside' and 'inside' of learning?

Finally, your emphasis on praxis—action connected with reflections—has helped us reimagine classrooms as spaces where students critique and shape their world.

In solidarity,
Niroj Dahal

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Dear Habermas,

I am writing this letter to you based on your work. I do hope many scholars will read it in the future. Your theories on communicative action and reflective discourse addressed the dilemma and shaped my approach to teacher development, wherein I informed teachers involved in facilitating STEAM workshops where dialogue was central. For instance, during sessions in Kalikot, I encouraged educators to share fears (e.g., confidence and resource limitations) and co-design solutions, aligning with your ideal of "undistorted communication."

For me, reforming practices emerged through collaborative reflection. When mentoring teachers like Mr. Shrestha (during my PhD field visit), I prioritized authentic insight—your guiding question—by critiquing assumptions (e.g., "traditional = effective"). Peer observations and feedback cycles mirrored your "public sphere" concept, fostering trust and iterative growth. Box poetic in mind, I realized that transforming leadership as a reflective teacher leader requires emancipatory reflection. Teachers moved beyond technical skills by integrating their lens to question power dynamics (e.g., principal-teacher, head of the department-teacher hierarchies). This empowered them to lead curriculum reforms, embodying your vision of rationality as a tool for liberation.

> Dear Habermas, your words inspire,
> Reflective paths, and teachers' fire.
> In Kalikot, we spoke out loud—our fears and hopes, both strong and proud.
> Where silence was, dialogues grew,
> and reform began with shared good, too.
> Your powerful view helped us see, leadership grows through inquiry, free.

Thus, your communicative action and reflective rationality theories resonate with my efforts to nurture teacher leadership. Through mentorship and collaborative inquiry, my peers and I engage in 'self-initiated professional development,' yet I seek clarity on how structured reflection fosters authentic growth. For example, diary reflections and peer feedback during STEAM workshops conducted by me prompted teachers to critique their pedagogical assumptions. Thus, as a humble offering to view the world from your perspective, I raised questions: How might educators systematize such reflection to transcend instrumental reasoning and cultivate emancipatory knowledge? And can the 'ideal speech situation' be realized in hierarchical school environments to democratize professional discourse?

With gratitude,
Niroj Dahal

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Dear Mezirow,

Your transformative learning theory informed my transition from teacher to reflective teacher leader. As informing began with disorienting dilemmas, Hari's near-resignation and Santosh's classroom struggles prompted critical self-reflection. Workshops on ICT integration and project-based learning became "trigger events" for both of them to challenge fixed mindsets. Likewise, reforming practices hinged on integrating viewpoints—your question—How do teachers resolve dilemmas through differing perspectives? —guided peer mentorship. When Aarati clashed with colleagues over student accountability, I used role-playing to reframe conflicts, fostering perspective-taking and adaptive solutions. <u>Box poetic in mind</u>, change-driven leadership requires meaning-making of the content for change. Participant like Kamal, who shift their instructions from rote memorization to inquiry as a transformation. By framing leadership as a shared, reflective journey, we cultivated "habits of mind," prioritizing collaboration over hierarchy.

Dear Mezirow, your words took hold, In classrooms where doubts were bold. From conflict came reflective strength, As fixed minds found shared insight at length. Through struggles and STEAM-led change, We bridged gaps, both wide and strange. Now new habits grow where minds once froze, In learning, transformation flows.

Next, your transformative learning theory frames my transition from teacher to leader, particularly during dilemmas like facilitating STEAM training in rural Nepal. When teachers resisted participatory methods, critical reflection on their perspectives—grounded in rote-teaching traditions—sparked a paradigm shift. Yet, how can educators navigate competing frames of reference without exacerbating dissonance? For instance, blending Hind 'Swaraj' (local agency) with STEAM education trends requires reconciling divergent values. How might your disorienting dilemma framework guide teachers to integrate, rather than merely tolerate, conflicting viewpoints? Finally, I believe your insights could strengthen participatory futures by transforming friction into collaborative growth.

In association,
Niroj Dahal

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Dear Gandhi,

Your philosophy of Swaraj—self-rule and rootedness in the community—presents my work. The notion of informing your viewpoints meant designing lessons that cover local knowledge, like using Nepali farming practices to teach algebra. Decorating classroom walls with local art (symmetry in mandalas) answered your question: How do we connect education to students' selves? <u>Box poetic in mind</u>, reforming practices involved decentralizing authority. As a community facilitator and reflective teacher leader, I nurtured "teacher-leaders" like Mr. Shrestha, who blended collective labor into math fairs, empowering students to lead projects. Transforming education demanded ahimsa (non-violence) in pedagogy. Replacing punitive grading with restorative circles helped low achievers thrive. Your concept of education as character-building promotes holistic development, which is enhanced by math class through the use of logic and empathy. Thus, your Swaraj perspective inspires my role as a community facilitator, where I link mathematics to Nepali traditions (e.g., tessellation in mandalas). However, neoliberal education often isolates students from

> Dear Gandi, your Swaraj continues,
> In math with mandalas and morning fields.
> Restorative circles, not harsh grades,
> Created classrooms where empathy stays.
> Swadeshi ideas in student projects,
> Connect roots and futures in local ways.
> Your path guides us as we build,
> A soulful school—free and connected.

their cultural selves. I raised the following questions: How might we ground pedagogy in Swadeshi (self-reliance) while resisting commodified curricula? For example, when students designed math models addressing local water scarcity, their agency flourished—yet systemic undervaluing of "non-Western" knowledge persists. How can teachers nurture authentic selfhood through education without romanticizing tradition? In closing, your wisdom could illuminate my pathways to holistic, participatory futures where learning embodies roots and innovation.

In reverence,
Niroj Dahal

Drawing as a reflective teacher leader of mathematics, in the following section, I have discussed my different roles and responsibilities in different times and situations based on my research participants and a critical friend viewpoint. So, I have begun the following section with a new beginning as a full-time mathematics teacher.

A New Beginning as a Full-Time Mathematics Teacher

I served as a part-time mathematics teacher in different schools in Kathmandu Valley. The part-time job was good at the beginning to update my career in mathematics. In this part-time position, at a later stage, after some years, I asked myself, how long will you serve as a part-time mathematics teacher? This question led me to think of some alternatives. So, in March 2015, with the help of one of my senior teachers, I got the next position as a full-time mathematics teacher at one of the schools in Kathmandu Valley.

It could have been any day in March 2015. I was in the process of looking for a full-time job as a mathematics teacher in a Nepali school because I was tired of working part-time, a role often referred to as a 'head-melt' mathematics teacher. Surprisingly, I received a call on that particular day from one of my senior teachers at the university with the proposal to be a full-time mathematics teacher. I was excited too about the proposal to visit the school as I am known to him and my profession. So, I accepted his proposal to be a mathematics teacher and undertook a new journey to be a mathematics teacher in a new school. The following week, I visited the school. I was fascinated by the school's environment. On the same day, I completed the school's recruitment processes. During the recruitment process with *interviews, I was more excited to be one of the members of the school community. After a week, I received the call with a congratulatory note. I said yes, and thank you!*

Upon receiving that call, I was excited to join the school. In April 2015, I started my new career as a mathematics teacher at a renowned school in the Kathmandu Valley. However, I had many questions wrestling in my mind, as my research participants—Hari and Kamal, and a critical friend—Naresh, such as how many classes I had to teach daily. How do I start the first class at class? What are the resources available in the school? How can I plan to teach the classes? What is school time? What are the professional development opportunities for me? What are the leadership opportunities to be a reflective teacher leader? In response to my inquiry, starting with seven days of teaching professional development workshops and sessions, I am ready to nurture the students with my mix of excitement and nervousness. The first day of school in April 2015 goes as follows:

As a newly appointed secondary-level mathematics teacher, I stepped into the classroom of grade IX for a long two-hour orientation class with a mix of excitement and nervousness. After entering the classroom with morning greetings to the students, I saw that the walls were decorated with colorful charts and posters, creating an inviting and inspiring learning environment. I took a deep breath, ready to start on this journey of teaching and positively impacting my students' learning and lives while teaching mathematics. The students looked curious and eager as they settled into their seats. I introduced myself, explaining my passion for mathematics and my commitment to helping them succeed. I could sense their anticipation; some even offered warm smiles to welcome me. I decided to share a personal story to break the ice and establish a connection. I spoke about my struggles with math during my school days back in 2002 and how I overcame those challenges with dedication and the support of my mathematics teachers. I emphasized that I believed in their potential, assuring them that we would work together to achieve great things. As the class progressed, I began introducing the curriculum, starting with a basic review of the topics they had covered in the previous year. I could see some students nodding along, their confidence gradually building. Others, however, seemed unsure and hesitant.

Recognizing the need to address their doubts and make the subject more relatable, I decided to connect mathematics to their everyday lives and experiences. I brought real-world examples that showcased how mathematics played a role in their communities and the world. For instance, I discussed the significance of geometric patterns found in traditional Nepali artwork and how they mirrored mathematical concepts such as symmetry and tessellation. I also shared stories of successful Nepali mathematicians who had made significant contributions in the field. To create an engaging and interactive learning environment, I incorporated group activities and problem-solving exercises as revision based on the Grade VIII contents. I encouraged students to work collaboratively, allowing them to learn from each other's strengths and perspectives. I realized that promoting a sense of friendship to develop rapport would foster a supportive classroom atmosphere. Throughout the class, I remained accessible, answering questions and providing additional explanations when necessary. I was also keen on adapting my teaching methods based on the students' diverse learning styles and varying abilities. It was essential to ensure that every student felt valued and challenged in a way that suited them. As the bell rang, signaling the end of the class, I could not help but reflect on the experiences I had shared with my students of grade IX in the first class. While it was just the beginning of a long journey, I felt a sense of fulfillment knowing that I had made a small difference in their mathematical understanding and confidence. I was determined to continue nurturing their growth and fueling their enthusiasm for the subject in the days to come. With each passing class of the day, I knew that my role as a mathematics teacher in the school held incredible responsibility. I was committed to fostering a deep appreciation for the subject, connecting it to their local context, and empowering my students to see the endless potential that mathematics had to offer.

Boxed poetic notions in my mind, I reflected on the process of becoming a full-time mathematics teacher. I have mixed feelings— nerves, tension, anticipation, and curiosity. So, the transition of becoming a full-time mathematics teacher is a challenging process that requires ongoing support, continuous development, and a mindset for change and agentic perspectives. My research participants—Aarati, Kamal, Hari, and Santosh—also reacted differently when they started their careers as full-time mathematics teachers.

I entered the room with a marker and hope,
A whiteboard, yet full of scope.
Their eyes, expansive windows, watched me stand,
A map of nerves, a heart unplanned.

The charts on the walls, the patterns bright,
Spoke silently in colored light.
Freire whispered, *"Begin with them—*
Not facts alone, but roots and stem."

So, I began not with theorems dry,
But with a tale of struggle, why
Numbers once blurred before my eyes,
Till care and practice made them rise.

They smiled—I spoke—not from a throne,
But from the path I'd made my own.
Habermas joined; his voice was near.
"Let dialogue replace their fear."

Hands raised with doubts, some voices low,
I paused to feel their inner glow.
From tessellations in temple stones
To market maths and farming loans.

Gandhi nodded, *"Let them see,*
Their village math is in symmetry."
No longer were these numbers cold,
They told of stories, brave and bold.

In small clusters, they worked as peers,
With laughter, wrongs, and tiny cheers.
Mezirow leaned in, soft and wise:
"Let dissonance help them rise."

With praxis born from lived insight,
From village dusk to classroom light,
I teach with heart, with hand, with call—
And learn, with them, the truth of all.

Aarati shared that '*it was all about learning my experiences as a problem solver. I have also been through the same stages in my beginning career path. So, qualities such as acceptance, growth mindset, and learning in collaborative seniors are vital in school mathematics.*' Kamal added that 'the *teaching and learning process and students' engagement are different and unique based on the mindset of the mathematics teachers and school environment while conducting their classes. In my earlier career, I would have liked to call myself a traditional mathematics teacher who simply relied on rote teaching and students who were good listeners to my lecturers.* Hari remarked that '*nerves, tensions, and curiosities are common traits and tensions while starting my career as a mathematics teacher. I have many stories to share with you about how I facilitated the* *classes in my earlier career. No support from the school administration or even from colleagues. I was even in the stage of quitting this profession.*' Santosh reflected that it was a tough job, with various struggles *even in one class. Nerves and tensions are the most influential factors in my earlier career as a secondary-level mathematics teacher.*'

Further, Wardhani et al. (2024) underline the importance of ongoing self-initiated professional development, and mentors play the vital role of being professionals by blending innovative ways of teaching and learning mathematics for 21st-century learners. However, there are challenges in recontextualizing knowledge from teacher education courses into actual teaching practice, specifically advocating for an inquiry approach to mathematics pedagogy. I started hearing them with boxed poetic notions in mind. It is envisioned that innovative and context-responsive approaches in mathematics offer students ample opportunity to inquire and be corrected while studying mathematical concepts. So, there is a need for pedagogical support and the importance of engaging students in active learning in mathematics.

With an altruistic motive
Serving others while meeting my needs
Perhaps, the servitude makes me Gandhi!

***

There is an urge to improve myself
With means appropriate for all
I try then help improve my students
Perhaps, my improving self, embraces Habermas!

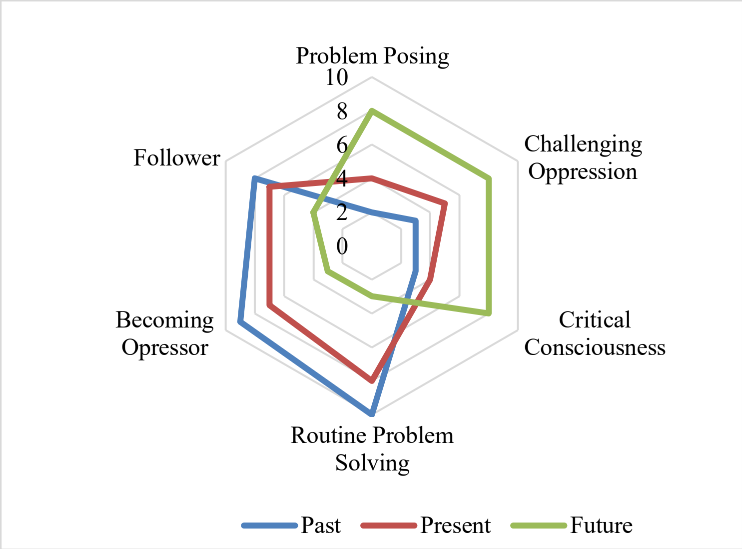
***

Slowly, I find myself in the contradiction
My preaching does not go with practice
I begin to examine my referents of life
Perhaps, I begin to move toward Mezirow!

***

My desire to dominate the class
Reproducing the image of my teacher
Who would control my knowing process
I remind of liberatory possibilities
Perhaps, I begin to look upon Freire!

Teaching mathematics is not an easy job, but it requires a leading role as teaching is leading. As I reflect on this process based on past, present, and future experiences from Freire's perspectives (Freire, 1970), my leadership development process would have given more emphasis on problem posing, challenging oppression, and critical consciousness as experience, activities, and learning outcomes, as portrayed in the adjoining figure.



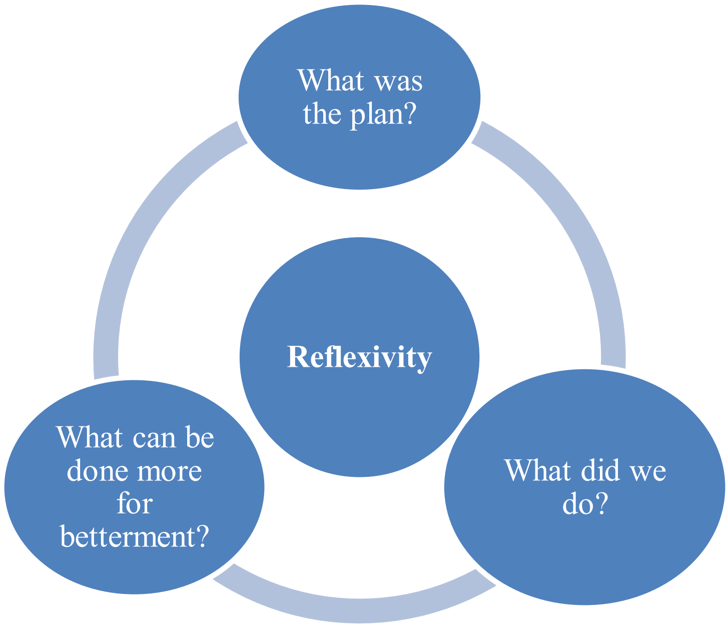
So, I considered teaching as leading. Teaching as a leading notion, embracing leadership principles of mathematics teachers to nurture students toward academic and personal development. Like effective leaders, teachers establish a clear vision, inspire motivation, and create environments that foster collaboration and critical thinking, offering constructive feedback, and tailoring instructional methods to address the needs, through meaningful discussions. Mathematics teachers act as leaders who empower students to reach their full potential. This approach is considered a transformative role of mathematics educators in shaping individual learner outcomes and contributing to broader societal progress by developing informed and engaged citizens.

Becoming a Community Facilitator of Mathematics

Abided by the principle of leadership as reflexivity, which involves reflecting on, in, and for my actions as outcome process-driven leader (Grint, 2010). Reflection on action is the most common act, done collectively and individually. As a community facilitator of mathematics in the middle of 2015, I got the opportunity to serve in different roles and responsibilities as a reflective leader for facilitating mathematics activities aligned with the vision, mission, and goals—those implicitly in your mind—of the school. My reflexivity is guided by three questions: What was the plan? What can be done more for the betterment? What did we do? as shown in the following Figure 13.

Figure 13

My Reflexivity



So, my role was multifaceted and rooted in the overall school philosophy of possibly progressive education. Demonstrating a leadership role in curriculum sequencing, designing daily lesson plans, decorating the mathematics walls of the school as well as classrooms, managing to support the low achievers in each class, nurturing mathematics teachers across classroom leadership to be more professional, and taking the lead role to conduct the mathematics events for the better learning experiences for the mathematic community in the school are the works that I have conducted in the school. Although these engagements may not entirely align to form the community but build the community and facilitate meetings for making the visions for actions and doing follow-ups (Owen & Buck, 2020). Table 7 shows my role and responsibilities.

Table 7

My Roles and Responsibilities as Community Facilitator of Mathematics

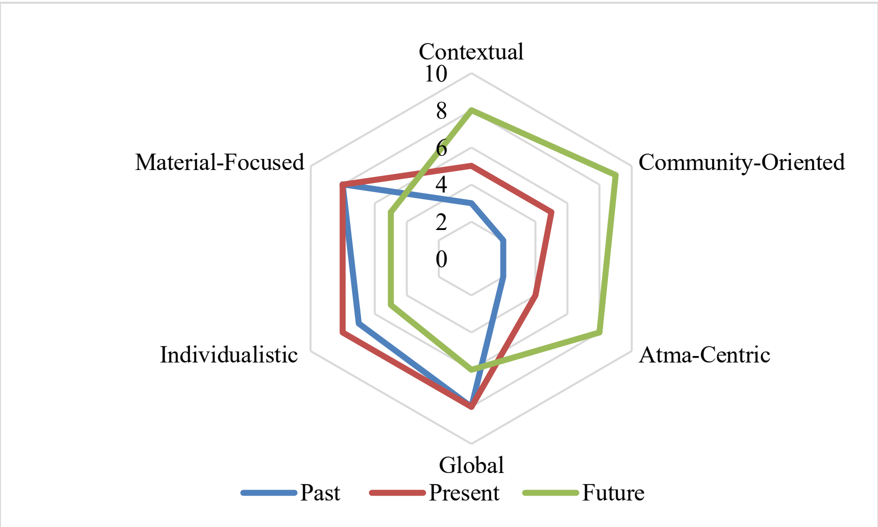
Areas	Roles and Responsibilities
Curriculum Sequencing	I have worked closely with teachers to ensure the mathematics curriculum is centrally and/or logically structured, building on previous knowledge and preparing students for future concepts. This involves careful planning and organization and understanding

	the unit, contents, objectives, teaching resources, teaching methodology, teaching hours of mathematics, and how students learn.
Designing Daily Lesson Plans	I have assisted schoolteachers in designing daily lesson plans. These plans are designed to meet the needs of all students, incorporating different approaches to teaching strategies to serve to different learning styles. I have ensured that each lesson is engaging, interactive, and promotes critical thinking and creativity.
Decorating the Mathematics Wall of Classes	One of my favorite tasks is decorating the mathematics walls of both the school and the classrooms in my time. I believe that a stimulating environment can enhance learning, and what better way to do this than by surrounding students with mathematical concepts? From number lines and geometric shapes to famous mathematicians and their contributions, the walls are a testament to the beauty of mathematical concepts, axioms and postulates.
Supporting Low Performers in Mathematics	A significant part of my role was to be involved in supporting low achievers in each class from grade VI to X. I have worked with those students individually or in small groups, providing additional resources and strategies to improve their understanding. I also interact with their teachers to monitor progress and adjust teaching methods.
Nurturing the Professional Qualities among Mathematics Teachers	I am passionate about nurturing mathematics teachers to be more professional by offering professional development sessions every second and last Sunday of the month. I organized regular workshops and training sessions daily, where we discussed the latest teaching methodologies, shared experiences, and learned from each other. I also provided one-on-one mentoring,

	offering guidance and support to help teachers grow in their roles.
Lead Mathematics Events	I took the lead role in conducting mathematics events in school. From math fairs and competitions to parent-teacher meetings, I ensured that these events were well-organized, engaged, and motivated to study mathematics. As a Community Facilitator of Mathematics, I created a supportive and stimulating environment where students and teachers can thrive in their journeys. It was a role I was proud to play to impact on the school's mathematics program positively.

Upon reflecting on being a community facilitator of mathematics and mathematics teacher in a dual role, I was always busy with various school activities that offered me ample opportunity to be corrected as a professional. It is true that "to facilitate teachers in a professional learning community requires that the facilitators place themselves in the teachers' shoes. *Placing oneself in another's shoes* is a classic instance of decentering as an attempt to adopt a perspective that is not one's own." (Carlson et al., 2007, p. 841).

As I reflect on this process based on my past, present, and future perspectives from the Swaraj perspective (Gandhi, 1909), my leadership development process would have given more emphasis on contextual, community-oriented, and Atma-centric approaches as experience, activities, learning outcomes, and some degree of pedagogical reconstruction without neglecting global, individualistic and material-focused leadership development process, as portrayed in the adjoining figure. These interactions and opportunities



for the mathematics teachers involve being part of the community, considering each teacher acts as an observer of the other for creating the models of the multiple ways of thinking, doing, being, and becoming, as I portrayed in the adjoining box texts. For instance, my research participant, Aarati, added that '*she was also closely working with the primary and secondary level teachers to achieve the learning outcomes, but she was worried because of the victim blaming games of the teachers to students and principal to teachers.*' Kamal suggested that '*mathematics teacher developed their art of teaching and gradually engaged students in learning processes by participating in professional activities by blending global and local tools, techniques and methodologies. I was also the one who continuously took part in the professional development activities conducted by the school and other agencies.'* Hari remarked that '*there are many critical issues such as students' achievements in mathematics, readiness issues, and even essential support mechanisms for the students. However, I have initiated some innovative techniques to engage myself and my students. These initiatives are designed to project works for indoor and outdoor activities and engage students in lab work with ample resources to explore their new ways of learning mathematics, such as developing the models and ICT tools.'* Santosh added that the '*math teacher's leadership role plays a vital role in learning and nurturing the students. Digitizing all the school activities is very important for me. So, I support all the mathematics teachers in blending ICT tools in mathematics pedagogy. I am in the process of forming a mathematics community in the school to support my colleagues.*'

> Community can be a site of deception
> Giving rise to hegemonies of all kinds
> From the unseen normalcy to opaque process
> To counteract these all, I welcome Habermas!
> ***
> Community as a basis of dialogue
> For a conscious meaning system
> Arising from people and the world
> To embrace these, I welcome Freire
> ***
> Community as a site of questioning
> Our collective and individual assumptions
> As a basis for a perspective of shift
> To work this further, I welcome Mezirow
> ***
> Community for outside-in self-contemplation
> For becoming aware of pride as limitation
> By embracing humility for community building
> To make self-ready for others, I welcome Gandhi

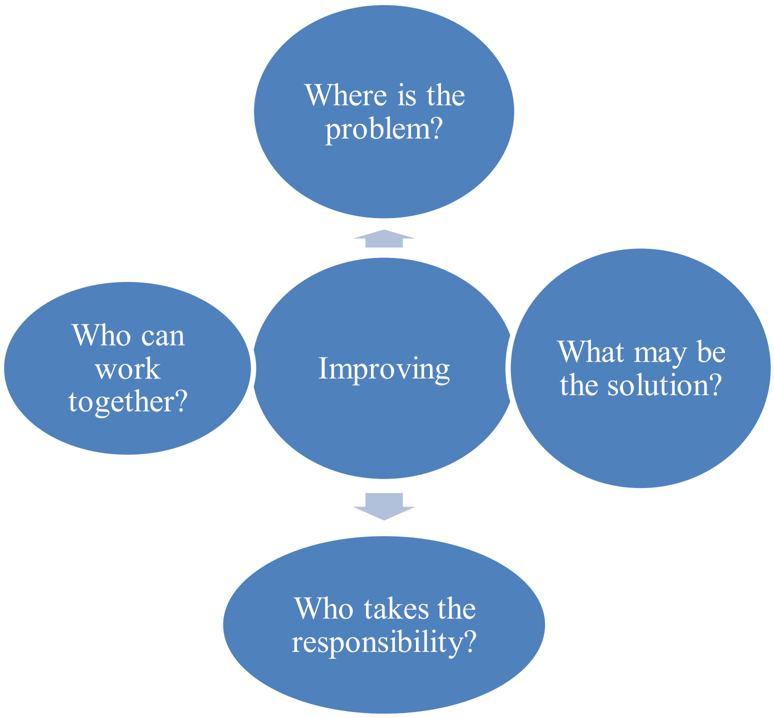
The school community's role is vital for the leadership development of mathematics teachers. Hou (2024) added that teachers can develop communities of mathematical inquiry, both in the physical classroom and through online platforms.

As I and other research participants have conducted, teacher communities are important in supporting educational reform and creating learning opportunities. So, the role of facilitators and/or mathematics teachers must be encouraging in these communities for collaboration and transformation, as well as challenging and expanding students' conceptions of mathematics.

Thus, arriving at this stage, I conceptualized that mathematics teacher leadership as a reflective leader includes active engagement for shaping and enhancing mathematics within their schools. This leadership includes mentoring colleagues, facilitating professional development, advocating for equitable facilitation practices, and spearheading curriculum reform. Effective mathematics teacher leaders utilize their pedagogical expertise to foster collaborative learning communities and promote evidence-based strategies that improve student achievement and teacher efficacy for connecting classroom practices with systemic changes, emphasizing reflective inquiry, data-driven decision-making, and aligning student-facilitating goals with broader educational standards. The notion behind this is to improve the overall engagement of learners. I attempted to reflect, 'Why are we working for? In the following Figure 14, as a reflective leader.

Figure 14

Why Are We Working For?



Immersing in the Leadership Development Process

In one of the early cool mornings of June 2022, I received a call from one of the personalities from the INGO to facilitate the STEAM-based training in Kalikot. Kalikot is one of the 77 districts of Nepal. I was in a dilemma. So, I asked him to call me after 1 hour. In that one hour, I called my colleagues to support me with possible suggestions for sharing the proposal. With his suggestions, I am ready to go.

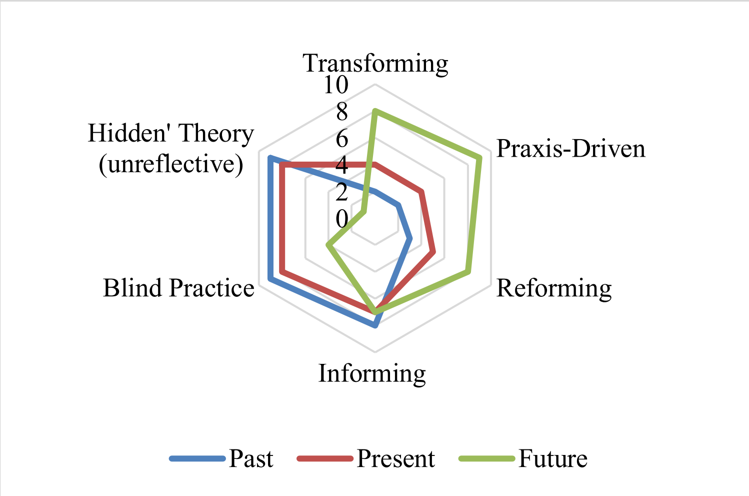
It could be one of the Fridays in June 2022. I am approaching Kalikot to facilitate the session on STEAM education. I moved from my room in Chhauni to the airport with mixed feelings. When shall I approach Kalikot? Where shall I sit? How shall I conduct the training? Is electricity available or not? (to name but a few questions). With different ups and downs, I reached Kalikot within 12 hrs by taxi from home, plane, another plane, and finally, by bike. This was new and a way of resiliency for me. With all the welcome and others, I went to bed at 8:00 pm. Because of the long trip, I fell asleep. Next day, I got up early in the morning. With my regular work, I moved for an hour for a morning walk in the Kalikot hills. It was a new experience for me.

After the refreshing visit, I was ready for the three-day STEAM-based training for schoolteachers, which provided regular training sessions and workshops to enhance their innovative teaching skills. However, during the sessions and workshops, I noticed that the teachers were improving at teaching STEAM subjects but lacked the leadership skills to initiate any activity. I realized that to transform the program truly, the teachers needed to be leaders who could inspire students, drive innovation in teaching methods, and contribute to the development of the different forms of the curriculum. With this realization, I decided to revisit the Professional Development program from day two. I aligned the day two activities with a leadership development process, focusing on improving the teachers' teaching skills and developing their leadership skills. The leadership development process included workshops and a mentorship where each teacher was paired with a mentor who guided them in their leadership journey. To offer practical experience, I set up collaborative projects where the teachers had to work in teams to develop innovative teaching methods and curricula. This allowed the teachers to apply their leadership skills in real-world situations. Over time, the teachers started to *demonstrate improvement. They were not just becoming better teachers but also influential leaders. They started to take the initiative and lead curriculum development projects. The leadership development process was a resounding success when I reached the final day of the program. It enhanced the teachers' leadership skills and enriched their teaching experience. The teachers were now ready to step into the classroom, not just as teachers but as leaders who could shape the future of education. Thus, revisiting professional development and introducing the leadership development process in the workshops and sessions was a new avenue for the schoolteachers.*

I felt that leadership development in the context of school mathematics is a complex process, as indicated in the boxed texts. Barth et al. (2024) remarked on the importance of leadership strategies in shaping and supporting lifelong learning, with external support and facilitation processes, and the role of professional development structures in developing teacher leadership. Likewise, Iqbal and Ali (2024) emphasize the value of professional learning in promoting reform and enhancing teacher professionalism, noting the positive impact of leadership on teacher professionalism and student performance. However, addressing wicked problems is guided by the following questions: What are my values and guiding principles? And how does the context/situation help or otherwise to act as per my values? Seek reflective exercises. Reflective exercises can also make mathematics leaders vulnerable as they need to accept their failures and limitations while dealing with wicked problems, such as mentoring colleagues, facilitating professional development, advocating for equitable facilitation practices, spearheading curriculum reform, and strengthening the overall engagement of mathematics through participatory pedagogy.

Habermas: Lead with an authentic insight Freire: Lead for unmasking oppressions Mezirow: Lead to resolve dilemmas Gandhi: Lead from inside-out

Thus, reflecting on these processes based on past, present, and future experiences from Mezirow's perspectives (Mezirow, 1991), my leadership development process would have given more emphasis on personal experience-based, reflecting critically and dialogic and dialectical opposing to normative, following the givens and one-way notional as experience, activities, and learning outcomes, as portrayed in the adjoining figure.



So, the focus is on the role of school leaders in driving professional development, the significance of principal leadership in professional learning communities, and the importance of building teachers' sense of ownership and shared goals. Equally, the critical features of professional development programs are fostering a professional learning community, developing teachers' knowledge, adapting professional development to local needs and challenges, and making potential improvements in designing and leading high-quality professional development.

Leadership Development Process in Mathematics Education

It could be any day in July 2020 when I attended Prof. Gautam's, one of the TPDs conducted by the training center. During the session, Prof. Gautam remarked that despite the department's academic excellence in the university and across the country, he noticed a gap in the students' skill set - leadership. He added that students needed to be skilled in the subject and possess leadership qualities to make significant contributions. He recognized that leaders in mathematics could drive innovation, inspire others, and contribute to the advancement of the field. With this realization, Prof. Gautam introduced a leadership development process in mathematics education. He started by organizing leadership workshops where students could learn about leadership theories and principles. These workshops were led by successful mathematicians who had demonstrated exceptional leadership in their fields. However, recognizing the necessity of practical experience, Prof. Gautam *shared that he introduced a mentorship program. Each student was paired with a mentor who guided them through their academic journey, providing valuable insights and helping them develop their leadership skills. Prof. Gautam set up collaborative research projects to further enhance the students' leadership skills. These projects allowed students to apply their leadership skills in real-world situations. They were responsible for managing their teams, setting project goals, and ensuring the successful completion of the projects. Over time, the students began to show remarkable improvement. They were not just becoming better mathematicians but also effective leaders. They started to take initiatives, lead research projects, and even organize mathematics symposiums. The leadership development process in mathematics was a resounding success. It enhanced the students' leadership skills and enriched their learning experience. The students were now ready to step into the world, not just as mathematicians but as leaders who could shape the future of mathematics. Thus, recognizing the necessity of a leadership development process in mathematics education led to a transformation in the university's mathematics department.*

The session by Prof. Gautam served as an inspiration, highlighting the importance of leadership development in education and the critical role of the leadership development process in mathematics education. So, strong leadership is necessary to support teachers' professional development and improve student performance. This is particularly important in schools of different socio-economic statuses, where instructional and transformational leadership and distributed leadership are crucial (Tan, 2024), and reflective exercises. Through reflective exercises, reflective leaders learned to admit limitations and weaknesses institutionally and individually, thereby lessening arrogance, limitations, and weaknesses among team members (Larsson et al., 2024). So, effective leadership in mathematics education requires focusing on content-specific leadership practices, developing leadership skills and teacher capacity, cultivating mathematically rich professional development environments, admitting limitations such as having the courage to speak out loud, expanding assets, and building competence. Thus, knowledge of leadership content is essential for improving instructional leadership in mathematics, with peer-mentoring programs to foster leadership practices among mathematics teachers.

Moving Forward with the Leadership Development Process in Mathematics Education

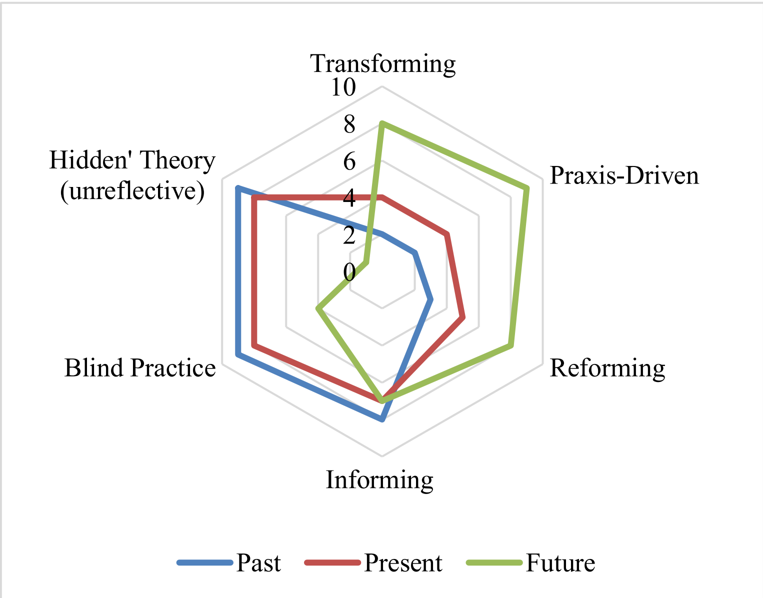
It could be any day in January 2021, and I attended a virtual session with Prof. Khadka, a visionary who believed in the power of leadership in transforming mathematics education. Prof. Khadka started the session by noting that the students excelled in their coursework; they lacked initiative and leadership skills. Thus, Prof. Khadka realized that for the students to make significant contributions to the field of mathematics, they needed to be leaders who could drive innovation and inspire others. Prof. Khadka decided to introduce a leadership development program. Prof. Khadka initiated by organizing workshops and seminars where students could learn about leadership skills and principles. According to Prof. Khadka, those sessions were led by successful mathematicians who had demonstrated exceptional leadership in their respective fields. Next, he introduced a mentorship program where each student was paired with a mentor. The mentors guided the students through their academic journey, providing them with valuable insights and helping them develop their leadership skills. To provide practical experience, Prof. Khadka set up collaborative research projects. These projects required the students to work in teams, allowing them to apply their leadership skills in real-world situations. The students were responsible for managing their teams, setting project goals, and ensuring that the projects were completed successfully. Over time, the students started work. They were not just becoming better learners but also effective leaders. They started to take initiatives, lead research projects, and even organize events at the university. The transformation was visible. The leadership development process was a decisive success. It enhanced the students' leadership skills and enriched their learning experience. The students were now ready to step into the world, not just as mathematicians but as leaders who could shape the future of mathematics.

Under the guidance of Prof. Khadka, the mathematics department moved forward, setting a new standard in mathematics education despite the fact that there were a few limitations, such as resources, IT support, and evaluations. This sharing from Prof. Khadka is an inspiration, highlighting the importance of leadership development by enhancing students' mathematical knowledge and leadership skills.

Drawing from emancipatory interest (Habermas, 1972), I have also examined and acted on leadership processes and outcomes driven by the values of many in the school setting, if not all (Smyth, 2024). So, the interest is not driven by ego or whims but by acting in favor of social justice, equity, and inclusion. School communities advance not just by privileging a select few mathematics teachers but by developing systems and frameworks that help nurture many teachers, if not all.

In this regard, Hendawy Al-Mahdy et al. (2024) emphasize the positive impact of leadership on teacher professionalism and student performance and the need for a shared goal and support structure in professional development. Likewise, emancipatory interest (Habermas, 1972) is considered a praxis embedded in organizational processes, including curriculum development, pedagogy, research, and community engagement. Indeed, emancipatory interest reminds reflective leaders of the fact that leadership processes and outcomes should always have a critical focus, thereby having a transformative orientation of any 'uncertain' human endeavor, including educational leadership.

Reflecting on the above processes based on my past, present, and future experiences from Habermasian emancipatory perspectives (Habermas, 1972), my leadership development process would have given more emphasis on transforming, praxis-driven, reforming, and opposing informing, blind practice, 'hidden' theory (unreflective) as experience, activities, and learning outcomes, as portrayed in the adjoining figure.



The role of university-school partnerships and instructional and transformational leadership in improving mathematics outcomes (García-Martínez et al., 2018; Rigby et al., 2018). So, empowering teachers as leaders through professional development focuses on the importance of leadership in mathematics education, addressing the challenges faced, and emphasizing the need for ongoing support and collaboration.

Case One: Hearing the Story of Mr. Paudel Leadership Development Process

It could be any day in July 2022; I was seeking the folk whose stories are vital for me to connect the mathematics teachers' leadership development process. I approached half a dozen folks in three weeks. Finally, I heard about one school in the Kathmandu Valley known for its exceptional mathematics results. Principal Mr. Paudel, an educator with a deep passion for mathematics, led the school as principal. In the formal meeting with Mr. Paudel in his office, he shared that he believes the key to a successful mathematics program is proficient teachers and teachers who continuously learn and grow.

Further, he shared that he understood that the field of mathematics was ever-evolving and that teachers needed to keep up with the latest developments to provide the best approaches to teaching and learning. I also believe that with this understanding, Mr. Paudel introduced a teacher's professional development process as a reflective leader at his school. In the discussion with Mr. Paudel, he shared that he has organized workshops and seminars on the latest developments in mathematics weekly after school on Friday. In one Friday session, he invited experts in the field and allowed the teachers to learn about new theories, methods, and applications of mathematics as all mathematics teachers are leaders of their respective classes. Next, he shared that he had introduced a peer-review system where the teachers could observe each other's classes and provide constructive feedback. This system allowed the teachers to learn from each other and improve their teaching approaches and facilitation processes. It was a fabulous movement for me because to further enhance the leadership development process, during the visit to the resources room, Mr. Paudel set up a room with the latest books, research papers, and digital and local resources on mathematics. He believed that the teachers were encouraged to use these resources to stay updated with the latest developments in the field. Mr. Paudel added that, gradually, the teachers started to demonstrate improvements. They were becoming better mathematics teachers and lifelong learners as reflective leaders by changing *the teaching and learning approaches. They started incorporating the latest teaching methods in their classes, decorating the mathematical wall with different practical activities and making the lessons more engaging and effective. While communicating further with Mr. Paudel at the school, he shared that the teachers' leadership development process was a resounding success. It enhanced the teachers' teaching skills and enriched their professional growth as leaders. The teachers were now ready to step into the classroom, not just as mathematics teachers, but as educators or leaders who were continuously learning and growing. Toward the end, I thank Mr. Paudel for appreciating his effort in nurturing the teachers' leadership development process and leaving the school with a commitment to visit again.*

> Freire whispered: "Let them speak,
> Not to fill but find what they seek."
> So, peer reviews and shared insight,
> Made every classroom a space of light.
>
> Habermas echoed: "Talk must be true,
> In dialogue, grow what's old and new."
> Teachers gathered, fear made thin,
> Each teacher's circle let trust begin.
>
> Mezirow stirred: "Let dissonance teach,
> Let struggle and shift expand your reach."
> With dilemmas faced and methods tried,
> Reflection became their inner guide.
>
> Gandhi hummed: "Teach from your soil,
> Let knowledge rise through rooted toil."
> The math walls told their local tale,
> Of patterns, and water pale.

Reflecting on the boxed poetic notions in mind. The mathematics teacher's leadership development process transformed the school's mathematics program. The above vignette inspires, emphasizing the importance of leadership development in school. The success of programs depends on meeting the needs and expectations of the teachers. So, the leadership development of mathematics teachers is a complex, ongoing process that occurs at various stages, motivations, and contexts (Avidov-Ungar, 2016). It involves a need for change and adjustment, driven by internal commitment and continuous actions and reflections (Yeo, 2013). This change can be facilitated by programs such as continuous professional development sessions, learning walks, and PD led by mathematics teachers, which might be a new avenue for mathematics teachers to help teachers develop new values and procedures for teaching mathematics. Even mathematics teachers can lead professional development initiatives as leaders, with teachers gaining a research-oriented attitude and changing classroom practices. However, the process of leadership development is not without its challenges, and there is a need for ongoing support and further development. So, considering an intervention of different forms of PDs that introduce an inquiry and innovative approach to mathematics instruction or facilitation can benefit teachers. Thus, growth as a leader of mathematics teacher educators is also a crucial aspect of professional development, with a need for its own signature feature-oriented model of growth mindset through action and reflection.

Case Two: Mathematics Teachers' Leadership Development Process

It could be any day in August 2020. On the way to facilitate the grade X compulsory mathematics class, I met the school's principal. In a quick meeting, the principal shared that she needs my help facilitating comprehensive leadership development sessions for mathematics teachers. I told her that I would help, as the school was known for its commitment to excellence in education. The school had long prided itself on nurturing both students and teachers as a leader, believing that the growth of one depended on the growth of the other. Among its many initiatives, the school has a comprehensive leadership development program for its mathematics teachers, one of which aims to transform dedicated educators into innovative leaders. As a passionate and experienced mathematics teacher, I have always been committed to my students. I believed that mathematics was not just about numbers and equations but a way to develop critical thinking and problem-solving skills for innovation. However, I often felt isolated in my classroom, disconnected from the broader educational community, and unsure of how to bring my innovative ideas to the classroom and life. As committed by the principal, the leadership development process at school begins next week, every last Sunday of the month, with ongoing support and guidance. I was assigned a mentor, and Ms. Bhattarai was assigned to help me. Ms. Bhattarai was a teacher with an understanding of both pedagogy and leadership. We met regularly, discussing her challenges and sharing resources for the sessions; the sessions were a great avenue for all the mathematics teachers to upgrade their teaching and learning, planning, and even confidence in designing and executing the lesson plans as reflective leaders. We encouraged all the teachers to think beyond traditional mathematics teaching methods. The school implemented a half-yearly teacher appraisal system as part of the program. This was not just a typical performance review but a reflective *process that involved self-assessment, peer feedback, student evaluations, and leadership initiatives for leading one of the major events of the school. Our experience with this process was very beneficial. According to the feedback, math teachers are good at making lessons interesting, but they could also do better in some areas, like using technology and projects in the classroom. After learning this, I started giving math teachers goals, such as making the lessons more interactive using digital tools. As part of the program, progress was constantly evaluated. We meet with the school's leadership team every few months to discuss how the math teachers excel in their leadership roles. The meetings were helpful, and the main topic was creating useful strategies to assist math teachers in reaching their objectives. In response to this change, the school gave most math teachers chances to learn about things happening in the world and their communities by sending them to conferences, webinars, and workshops. At a conference on global mathematics education trends, one of the math teachers, Mr. Shrestha, was especially inspired by hearing about new ways to teach math from teachers worldwide. Additionally, Mr. Shrestha's school pushed him to encounter new difficulties. He was given the chance to teach his coworkers new skills, building a culture of working together by sharing what he had learned. His confidence grew after the experience, and he realized that being a leader wasn't just about being in charge; it also meant giving other people power. Most of the math teachers' teaching and leading styles for school events like the math fair and mathematics exhibition changed a lot as the school year went on. When school started, the classrooms were full of activity because of this initiative, and the students were more involved than ever. It worked really well for Ms. Maharjan's students because she started using technology to make her lessons more interactive. Her coworkers also started coming to her for advice on different aspects of teaching, so she became a mentor and reflective leader. Overall, by the end of the year, all of the teachers had improved as teachers and taken on leadership roles in the school events. Thus, the school's leadership development program turned me from an enthusiastic teacher into a confident and creative leader, ready to motivate others and keep growing professionally. Making this change was about each person's success and making a chain reaction that would help the whole school. My journey was a testament to how important it is to support* *teachers like Mr. Shrestha and how powerful it is to offer ongoing help, opportunities for self-evaluation, and international and local exposure.*

My career path shows that teachers can become leaders with the help of mentors as mentors and mentees, changing the future of education in their communities. Improving the leadership skills of math teachers shows how important it is to make the workplace supportive and give teachers chances to grow professionally. I have conceived of 'doing' leadership as an individual and collective journey governed by the principles of selflessness, detachment, and humility, and it is aimed at getting things done through a participatory model. This journey draws strength from the individual's and team's vulnerabilities and constraints, striving to cultivate a deeper, more genuine understanding of past, present, and 'uncertain' future actions for the transformative potential of everyone. Attard et al. (2021) stress how important it is for teachers to be able to lead their own professional development through inquiry-based programs and collaborations. The above story shows how teacher leadership affects the success of students and their peers, which leads to better professional growth, and shows how important it is to develop certain norms and practices in mathematics professional development. Drawing from the boxed poetic expression, doing leadership as transformative and/or reflective leaders is instrumental in fostering an environment where equity, inclusivity, and social justice are a matter of praxis woven into uncertainties and complexities. Furthermore, the concept of non-attachment is integral to this leadership philosophy (Fry & Vu, 2024), embodying the readiness to relinquish authority and status whenever necessary,

No longer confined to classroom walls,
Where silence echoed down the halls,
But now, with Bhattarai by side,
In dialogue, our doubts we would confide.

Freire whispered, "Teach to think, not store,"
So, we broke the banking model's core.
Students led, co-learners all,
From rigid scripts to questions tall.

Habermas spoke through circle talks,
In peer review and feedback walks.
Trust was built through an honest voice,
Reflection made the wiser choice.

Mezirow stirred when change felt near,
When dissonance replaced the fear.
From set routines to global trends,
We grew through shifts that never end.

And *Gandhi* walked with quiet grace,
In Swadeshi steps, we found our place.
Math from fields, and fairs we led,
With hearts and minds and culture fed.

ensuring that the mission and the collective good always take precedence over personal ambition.

Concluding Thoughts and Evolving Vision of the Leadership Development Process

Figure 15

My Evolving Vision of the Leadership Development Process

(Figure generated from field text, 2024)

Figure 15 illustrates my reflectively generated components of my evolving vision of the leadership development process in school mathematics (in a dialectical sense co-arising with otherwise conceived opposites such as authoritarian leader and reflective leader) in school mathematics across past, present, and future perspectives. My past, represented by the blue line, shows lower values across most axes for the components of authoritarian leader, including global, individualistic, material-focused, informing, blind practice, hidden' Theory (unreflective), normative, following the given, one-way motivational, routine problem solving and becoming an oppressor. The zone created by these components may represent a lesser extent of the leader development process. Given my present situation as a teacher educator and interacting with my participants and critical friends, it offered the impression that there is a visible shift toward the role of a reflective leader. At the same time, I felt that it is not sufficient to imagine the world with a praxis-driven orientation (Habermas, 1972), a critically aware leader (Freire, 1970), reflect critically (Mezirow, 1991), and become aware of community-oriented engagement (Gandhi, 1909). The future perspective, shown by the green line, displays higher values across all axes of reflective leader, contextual, community-oriented, Atma-centric, transforming, praxis-driven, reforming, personal experience-based, reflecting critical, dialogic and dialectical, problem posing, challenging oppression and critical consciousness, indicating a vision for the future where reflective leader for the school is developed.

Drawing from Freire (1970), Habermas (1972), Mezirow (1991), and Gandhi (1909) with different perspectives, viewpoints, and theoretical grounds as a reflective teacher leader. The leadership development process in school mathematics is an involved and complicated journey with many challenges and learning opportunities for mathematics teachers. Leadership is vital to positively impact mathematics teachers' professionalism, teaching and learning processes, and student performance (Shen et al., 2020) in mathematics. Mathematics teachers benefit from different forms of leadership practices—instructional, transformational, and distributed leadership (Almarshad, 2017) as reflective teacher leaders. Instructional leadership for mathematics teachers involves setting high standards, providing professional development, and promoting evidence-based teaching practices (Tsakeni & Jita, 2017). Transformational leadership practices include modeling the way, inspiring a shared vision, challenging the process, enabling others to act, and encouraging mathematics teachers in the teaching and learning process. Distributed leadership encourages all mathematics teachers to make the day-to-day practice of school instruction more transparent by examining how school mathematics leaders work to manage and improve the overall instruction of the school.

However, supporting teachers' professional development in practice-based schools can be challenging in improving mathematics planning practices, transforming cultures, and increasing the use of quality tasks (Santagata & Yeh, 2014;

Yendol-Hoppey et al., 2018). So, the reciprocal relationship between subject matter and leadership strategies of mathematics teachers also plays a crucial role. However, as a victim-blaming game, the impact of school mathematics leaders might be compromised by a lack of time, confidence, expertise, and funding. Thus, there is a need for effective leadership in school mathematics with the qualities for building trust, balancing internal and external accountability, and managing developmental processes.

Swa Inquiry: First-Person Reflections

The transformation experience has struck me and has brought to my life and career as I reflect on my transition from a part-time mathematics teacher to a full-time educator and community facilitator. Initially, my part-time position functioned as a stepping stone, enabling me to maintain a connection to my passion for mathematics while navigating the uncertainties of my professional trajectory. Nevertheless, as time progressed, I began to doubt the longevity of this arrangement. The pivotal moment occurred when I posed the question to myself, "For how long will I continue to serve as a part-time educator?" This inquiry initiated a period of thoughtful introspection, which ultimately motivated me to pursue a more permanent and fulfilling position. I embarked on a new chapter in March 2015 by becoming a full-time mathematics teacher. The transition was both thrilling and intimidating. I vividly recall the combination of excitement and apprehension that enveloped me as I entered my first classroom at the new school. I was filled with hope and determination by the vibrant environment, which was adorned with colorful charts and posters. I introduced myself to the students, sharing my personal journey with mathematics, including my struggles, triumphs, and unwavering dedication to their success. The student's initial class was a mixture of curiosity and apprehension; however, I was resolute in establishing a supportive and engaging learning environment. I realized that teaching is not solely about delivering content but also about establishing meaningful connections with students as I matured in my position. I integrated real-world examples, group activities, and problem-solving exercises to make mathematics more interactive and relatable. The delight of witnessing students gradually develop confidence and become more engaged with the subject matter was gratifying. Nevertheless, the journey was not without its obstacles. I was perpetually preoccupied with inquiries regarding professional development opportunities, available resources, and class schedules. The initial days were a mixture of excitement and uncertainty;

however, the assistance of my colleagues and the school administration enabled me to overcome them. I acknowledge the significant responsibility and opportunities that my dual role as a community facilitator of mathematics has presented as I reflect on my experiences. My responsibilities were multifaceted, ranging from the organization of mathematics events to the sequencing of the curriculum. I took pride in fostering a stimulating learning environment, organizing professional development sessions, and supporting students and my colleagues. This experience has instilled in me the significance of adaptability, continuous learning, and collaboration. The transition to a full-time position as a mathematics teacher and community facilitator has been a transformative experience. It has reaffirmed my conviction that education has the capacity to influence the lives and communities of individuals. I remain dedicated to pursuing a positive impact in mathematics education, embracing the challenges, and continuing this journey.

Thus, it is clear to me as I contemplate my journey, that I transition from a part-time to a full-time mathematics teacher was a critical moment in my professional trajectory. The decision to pursue a more permanent position was motivated by a yearning for personal development and satisfaction. Consequently, the Swa inquiry has served as a reminder of the significant role that personal reflection and self-awareness have played in developing my professional trajectory as an educator and leader. I have developed a thoughtful understanding of my role and responsibilities by reflecting on my experiences, including the challenges and successes. This introspective practice has not only aided in identifying areas in which I can improve, but it has also motivated me to adopt a mindset dedicated to continuous improvement. I have realized that self-reflection is a means of personal development and a fundamental component of effective leadership. Subsequently, the Swa inquiry has further heightened my awareness of the significance of comprehending the distinctive context in which I instruct. It has inspired me to contemplate the ways in which cultural, social, and economic factors influence my students' learning experiences. I am better prepared to develop educational practices that are both relevant and meaningful to the lives of my students by establishing my leadership on this understanding. This reflection has reaffirmed the notion that effective teaching and leadership necessitate a more complex comprehension of the learning environment than merely a knowledge of content. Consequently, the Swa inquiry has underscored the importance of continuous professional development in my development as an educator. Participation in workshops, seminars, and mentorship programs has not only kept me informed about the most recent educational theories and practices but has also motivated me to remain responsive and adaptable to the evolving needs of my students. This reflection has reinforced my conviction that learning is a lifelong endeavor, and as a teacher, I am obligated to consistently pursue opportunities for growth and development in order to serve my students and community more effectively.

Twam Inquiry: Second-Person Relational Reflections

I connected with the Twam inquiry, especially how it stressed the importance of working together and being part of a community to develop leadership skills. I now understand how working with peers, sharing experiences, and helping each other out can really help me grow as a teacher. Creating learning communities and professional networks has helped me become a better teacher and encouraged everyone to keep improving. This spirit of working together has reminded me that being a leader isn't a solo journey but a group effort in which everyone shares responsibility and everyone grows. It's also been helpful to learn how important peer feedback and mentorship are, as the Twam Inquiry showed. Mentors with a lot of experience and constructive feedback from coworkers have given me new ideas and hands-on help, which has helped me improve my skills and ways of doing things. This collaborative environment has made me feel like I belong in the educational community even more, and it's shown me again that leadership works best when it's shared and includes everyone. By letting more than one teacher take on leadership roles, we can make changes to education that last longer and have a bigger effect, using each person's unique strengths and points of view.

Tat Inquiry: Third-Person 'Universal' Insights

I have been motivated by the Tat Inquiry's emphasis on student-centered learning and innovative teaching methods. Incorporating interactive activities, real-world problem-solving, and technology into my teaching has revolutionized the way I interact with my students. I have witnessed the potential of dynamic and student-centered pedagogies to enhance the relevance and engagement of subjects such as mathematics by transcending traditional rote learning. This method has motivated me to consistently investigate novel methods of establishing a connection with my students and enhancing the interactive and meaningful nature of the learning experience. Consequently, the Tat Inquiry's emphasis on comprehensive development has also had a lasting impact on me. I have realized that education is not solely concerned with academic success; it also involves the development of students' emotional, social, and personal well-being. I can more effectively address the diverse needs of my students and assist them in the development of well-rounded individuals by establishing a supportive and inclusive classroom environment. This comprehensive approach has reaffirmed my conviction that the foundation of meaningful and enduring educational outcomes is the promotion of students' overall well-being.

Reflections

Swa inquiry has helped me grow as a mathematics teacher and change as a leader. The importance of self-reflection and self-awareness that it has emphasized has helped me understand my role and responsibilities better. I have considered my successes and failures to find ways to improve and encourage a mindset of always getting better. This practice of thinking about myself has become an important part of my leadership because being self-aware is the key to growth. Also, the Swa inquiry has helped me understand the importance of being aware of context in the classroom a lot better. By understanding how cultural, social, and economic factors affect my students' learning, I have been able to make my teaching methods more relevant and useful. As a result of this realization, I have a much better understanding of how to teach effectively, taking into account both the subject matter and the unique learning environment in which my students work. So, from the Twam inquiry, I have a much better understanding of leadership as a shared responsibility. Participating in mentorship, getting helpful feedback, and working with peers have shown me how group efforts and distributed leadership can make a big difference. This method has helped build a sense of community and continuous improvement. It is a good reminder that growth works best when everyone works together. The Tat inquiry makes me want to use new, student-centered ways to teach. I have seen that using technology, interactive activities, and real-life problem-solving makes learning more fun and valuable for my students. Along with how well students do in school, I now pay more attention to their emotional, social, and personal well-being because of the focus on holistic development. Also, these new ideas have changed how I think about leadership and teaching, making me realize how important it is to be creative, work together, and think about what you are doing to create meaningful learning experiences.

So, meaningful journeys of my journey as a mathematics teacher begin with mastery of content and immersion into a transformative learning process that reshapes perceptions, values, and pedagogical approaches. I believe transformative learning theory (Mezirow, 1991) is a change-driven framework for understanding this shift. As I transition from theoretical knowledge to real-world classroom practice, I encounter disorienting dilemmas that challenge their preconceived notions about teaching and learning mathematics. These dilemmas often lead to critical reflection of different ups and downs in my critical movements, where I reassess my assumptions and beliefs, transforming my teaching identity and practice. Moreover, as advocated by Freire (1970), critical pedagogy plays a critical role in this transformation as a leader. It embraces the principles of dialogue, problem-posing education, and conscientization, moving beyond the traditional transmission of knowledge and fostering a more participatory and critical classroom environment. This shift empowers my teachers and students as co-creators of knowledge and positions teachers as facilitators of learning rather than mere transmitters of content. Thus, a new beginning as a full-time mathematics teacher is marked by adopting a transformative and critical pedagogical stance, laying the foundation for an effective leadership role during my career.

In addition to "A New Beginning as a Community Facilitator of Mathematics," I increasingly find myself serving as a community facilitator, bridging the gap between the school mathematics curriculum and the school community. This role fits with the Swaraj view (Gandhi, 1909), which stresses the value of independence, local knowledge, and community involvement in education. As a facilitator, I was just a teacher; I was also an example of how to give the school community power through math activities and new ideas. Gandhi thought that schools should be based in the community so that the lessons would reflect the area's culture, needs, and knowledge systems. As a math teacher in this role, other math teachers and I become agents of change who promote math literacy and critical thinking outside of school. In the same way, we can work together with people in the school community to find local problems that can be solved through math. This makes mathematics useful and easy for everyone to understand. This method improves everyone in the school's math skills and makes people feel like they own and are proud of their local knowledge. Next, it is important to note the difference between professional development and leadership development in math education, but this is something that is often missed. Professional development usually focuses on helping teachers learn more about the subject and better ways to teach, so they can do their jobs better. Leadership development, on the other hand, prepares teachers for bigger roles in their school communities. Drawing on Mezirow's transformative learning theory, professional development is seen as a first step in a teacher's journey, where teachers undergo personal transformation through critical reflection on their practice. Leadership development, however, is the next step, where teachers move from personal transformation to systemic change, influencing educational practices and policies at a higher level. Freire's critical pedagogy supports this development even more by encouraging teachers to lead in changing how schools work, questioning the status quo, and striving for more fair and equal ways of doing school activities. This change from professional development to leadership development is about getting new skills, a new way of thinking about math education, and a new vision for it. As a result, more and more people realize that leadership development in math education is necessary for long-term educational reform. As schools and school systems face more difficult problems, there is a greater need for teacher-leaders who can help their communities find new ways to solve these problems.

Using participatory future studies (Ollenburg, 2019) as a basis for discussion, these ideas offer a forward-looking look at how math teachers become leaders. They stress how important it is to prepare teachers to see and change the future of math education. This method encourages teachers to do activities that help them think about possible futures and develop ways to improve those futures. Thus, participatory methodologies can lead collaborative efforts to co-create the future of mathematics education, ensuring that it remains relevant and responsive to the needs of students and society. While moving forward, leadership development in mathematics education must be given the attention it deserves. This calls for a change in the way teacher education programs are set up so that they focus on teaching leadership, critical thinking, and getting involved in the community. For the most part, leadership development programs that use Mezirow's (1991) transformative learning theory, Freire's (1970) critical pedagogy, Gandhi's (1909) Swaraj perspective, and Ollenburg's (2019) participatory future studies will provide a complete framework for teaching math teachers how to be good leaders. These theoretical perspectives offer a holistic approach to leadership development, addressing teachers' personal and professional growth and their ability to lead systemic change in school mathematics. Even in Case One: Mathematics Teachers' Professional Development Process, I examine the professional development process of mathematics teachers, focusing on how transformative learning experiences have impacted my and other mathematics teaching practices. Through critical reflection and engagement with new pedagogical approaches, these teachers have undergone significant personal and professional growth, leading to improved classroom outcomes. Case Two: Mathematics Teachers' Leadership Development Process. I also attempted to explore the leadership development process of mathematics teachers, and I have taken on leadership roles within school communities. With the principles of critical pedagogy and participatory future studies, I have successfully led initiatives to reform school mathematics, demonstrating the importance of leadership development in achieving sustainable change. In sum, the leadership development process in school mathematics is crucial to educational reform. Utilizing transformative learning theory, critical pedagogy, the Swaraj perspective, and participatory future studies, I sought to comprehend the intricacies of this process and its potential to influence the future of school mathematics. As I progress in my career, it is imperative to foster and cultivate the leadership capabilities of mathematics educators, ensuring they are prepared to guide mathematics classrooms and school communities toward a more just, equitable, and fair future of mathematics.

Chapter Summary

This chapter reflected the inquiry of my leadership role and the leadership development process as a reflective teacher leader within the context of school mathematics, highlighting its impact on teachers and overall school achievements. Building on the brief reflection in Chapter I in the subheading "Community Facilitator: Nurturing Leadership Development Process", I narrated my journey from a mathematics teacher to an educator and researcher. The chapter is structured around key phases of my career, starting as a full-time mathematics teacher and transitioning to a community facilitator, which embraces my professional and leadership development. It includes cases of professional and leadership development processes for mathematics teachers. The chapter is grounded in critical pedagogy (Freire, 1970), knowledge constitutive interests (Habermas, 1972), transformative learning theory (Mezirow, 1991), Swaraj's perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019). It addressed the research question: How has the leadership development process (teacher as a change agent) been implemented in school mathematics education? In the following section, I share my reflections and insights as I approach this transformative journey.

PHASE III
TRANSFORMATIVE JOURNEYS OF REFLECTIONS, REALIZATIONS, AND STARTING AFRESH

In this phase, I sought to share my transformative journey by reflecting and revealing my experiences and insights through the lens of the Swa-Twam-Tat inquiry, which aligns with the Gyāna Pranāli design space of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and Prājyanvāda. Now, I am in the stage of thoughtful reflection and realization, navigating the complexities and fluctuations of Swa (the individual self), Twam (relational selves, i.e., other, research participants and a critical friend), and Tat (you, the readers as universal self). Guided by the questions: how did my project evolve over time? What challenges did I encounter, and what were the moments of accomplishment? How did my personal experiences influence my research in the Swa-Twam-Tat context? What impact do I foresee for my vision of STEAM-based mathematics education? What valuable lessons have I learned throughout this process? And what directions do I envision for future research based on my insights and research experiences?

CHAPTER VIII
REFLECTIONS AND WAY FORWARDS

Reflecting on the overall process of my inquiry, this chapter offers the Twam as relational selves and readers as universal selves (i.e., Tat) the opportunity to know how I have formulated the inquiry agenda for STEAM-based mathematics education for citizenship education and beyond. Likewise, I have reflected on the context, formation, and emerging research questions for this inquiry. Theoretical referents and perspectives also have room for reflection before responding to each emerging research question. Also, I have attempted to reflect on the novelty of my inquiry and the level of contribution methodologically and conceptually. For Twam and Tat, I have discussed how my inquiry is associated with national priorities. Later, I have highlighted the limitations of my inquiry before the final remarks. I have offered my thoughts as final remarks aligned with the question—what I have expected, and where am I now? I concluded this chapter with the way forward.

Formulation of Inquiry Agenda

As a Ph.D. scholar in transformative STEAM-based mathematics education, I am committed to developing a research agenda reflecting my personal and academic journey and contributing to a deeper understanding of how these insights can inform and drive educational reform. My prior academic pursuits, including my M.Ed. and M.Phil. degrees, have focused on questioning conventional, teacher-centered teaching methods. Instead, I have championed a student-focused approach that weaves cultural and relational aspects into the composition of mathematics education (See Chapter 1). Those studies M Ed in Mathematics Education (See Dahal, 2013) and MPhil in Mathematics Education (See Dahal, 2017) emphasized the critical need for relationship-building within the educational framework—extending beyond teacher-student dynamics to encompass community-school interactions, thereby fostering a more engaged and meaningful educational process for nurturing 21st learners.

Building on these realizations, my inquiry is to integrate local and global technologies in education, transcending traditional pedagogical methods to support a more creative learning environment. My academic network has expanded and is in the process of expanding. My knowledge base has been updated by my active participation in national and international conferences and my work as a community facilitator, where I developed leadership skills as a reflective leader among mathematics teachers.

Moreover, my engagement with continuous publications from 2020 to 2025 as a PhD scholar serves as a testament to the continuous learning and adaptation in my field, contributing to my development as a scholar invested in crafting educational transformations that are reflective, transformative, and inclusive of the diverse Nepali context. This inquiry features my commitment to a transformative educational praxis responsive to the evolving needs of learners and educators in a rapidly changing world.

With an MEd and an MPhil in mathematics education, as well as ICT skills, experience as a community facilitator, and knowledge gained from conferences, symposiums, and publications from 2020 to 2025 (**See appendix III**), I began my PhD at Kathmandu University School of Education (KUSOED) with a focus on STEAM education. STEAM education is an educational system that integrates science, technology, engineering, arts, and mathematics to foster students' creativity, critical thinking, and problem-solving skills. My main objective is to envision a STEAM-based math education that makes math more useful and effective in both teaching and learning settings for developing citizenship education, as expressed in the adjoining box. My inquiry aims to create a STEAM-based learning environment that uses methods from different fields and follows current educational trends around the world to promote citizenship education.

Not everything
That came to my mind
That ran through my heart
That flow through my vessels
I wrote!

The words fell short
The phrases could not give a sense
The sentences became meaningless
The paragraphs appeared oxymoronic
The chapter could not be deciphered

Many feelings were ineffable
I tried to express one thing
At times it became otherwise
The conventions were constraints
The truth emerged out of nowhere.

Whose interest did I serve?
Whose worlds did I represent?
Whose dilemma did I address?
Whose community did I build?

This is a thesis.
This is not a thesis.
This is final.
This is not a final.

Throughout my inquiry, I have explored STEAM-based mathematics education in the areas of curricular spaces, school and school community involvement in developing an engaged pedagogical process in the school mathematics classroom, teacher professional development initiatives around school mathematics education, and leadership development processes of school mathematics education. Moving forward, I aim to deepen my investigation into these areas, focusing on the potential of engaged educational processes that foster innovation and community involvement, teacher professional development, and leadership in STEAM education. Through my work, I aim to foster a transformative change in the way mathematics is taught and viewed, cultivating future innovators by integrating local and global knowledge with a strong emphasis on citizenship education.

Context, Formation, and Reflection of Emerging Research Questions

Reflecting on my educational journey, my inquiry began questioning the backdrop of traditional and conventional forms of education, largely aligned to the one-size-fits-all framework, such as homeschooling and Gurukuls, which predated the formal establishment of structured educational systems. With democracy in 1951, education became more organized. Rote learning and compartmentalized curricula have persisted, confining knowledge to textbooks rather than developing real-world multidisciplinary or interdisciplinary skills. This observation attracted my interest in STEAM-based mathematics education, which emphasizes critical thinking, reflection, and cross-disciplinary learning. I have seen teaching reduced to knowledge transfer throughout my career as an educator and researcher. In school mathematics, learning often feels disconnected from real-world contexts. Since curriculum updates have lagged behind global advances, the system stifles creativity and critical thinking, opposing what Schubert (1986) offers: a curriculum that has multiple colors, multiple aspects, and multiple dimensions as per the needs of 21st-century learners. Recent federal education reforms in Nepal have allowed for more localized and innovative education (CDC, 2019). This shift even allows mathematics education to be reimagined and redesigned to address global issues like climate change while remaining grounded in local needs and cultural contexts for citizenship education. As expressed in poetic form in the adjoining text box, for increasing my commitment to a transformative STEAM-based approach, I envision an educational system that is thoughtfully connected to the community and responsive to local and global

> I started my journey to break away from tradition,
> Aiming to broaden vision of STEAM education.
> Using STEAM, where math connects with life,
> Breaking barriers, making learning feel right.
> My research hopefully blends global and local
> Points to a future where learning is meaningful and authentic.

challenges. My research questions have focused on how to use STEAM education to create an innovative, community-engaged educational system that can meet local and global needs as a citizen of any nation. This involves exploring multidisciplinary approaches that combine mathematical theory with practical applications to ensure that learning transcends disciplinary boundaries and transforms society.

Looking back on my Theoretical Referents and Perspectives

Reflecting on my inquiry, I am motivated by the complex interplay of Eastern and Western theoretical referents and perspectives that direct my inquiry of transformative STEAM-based mathematics education. This mission is fundamentally rooted in the theoretical referents of transformative learning theory (Mezirow, 1991), Habermas's concept of knowledge-constitutive interests (1972), Freire's critical pedagogy (1970), Gandhi's Swaraj perspective (1909), curriculum images (Schubert, 1986) and participatory future studies (Ollenburg, 2019). These theoretical foundations influence my perspective and enhance discussion with Twam and Tat (i.e., participants and a critical friend, inviting readers) to engage in a collaborative investigation into the potential of educational transformation. Mezirow (1991) posited that transformative learning theory is essential for cultivating an environment where critical reflection motivates personal and communal transformation as expressed in poetic form in the adjoining box. This theoretical referent allows me to explore the sociocultural assumptions that influence educational practices, thereby facilitating the transition from traditional methods to change-driven approaches. Furthermore, Habermas's knowledge-constitutive interests (1972), the emancipatory interest, encourage me to challenge the "taken-for-granted assumptions" in mathematics education. This viewpoint has been crucial in reevaluating school and community involvement, curricular design, teacher professional development, and leadership processes, thereby cultivating a critical consciousness that is attuned to the socio-political dynamics that influence education. Similarly, critical pedagogy (Freire, 1970) has motivated a thorough examination of educational structures, curricula, and teaching practices that perpetuate inequity. Through this perspective, I endeavor to deconstruct the "banking model" of education and promote a dialogic, liberating pedagogy that is indispensable for the

East meets West in thought's embrace,
Mezirow's call, a shifting place.
Freire resists, Habermas frees,
Gandhi dreams with grounded pleas.
With Schubert's lens and futures nearby,
We co-create with hope and fear—
A dialectic path made clear.

empowerment of the mathematics education community. I argue for self-rule and autonomy, critiquing the influence of modern civilization on education from the Swaraj perspective (Gandhi, 1909). This is in accordance with my aspiration to develop a STEAM-based curriculum that combines innovation with local cultural and ethical values, thereby promoting a transformative educational experience. Schubert's 1986 book, *Curriculum: Perspective, Paradigm, and Possibility*, explores different metaphors and images to describe curriculum. It covers traditional views like curriculum as subject matter and planned activities, as well as progressive perspectives such as curriculum as experience and social reconstruction. These insights provided a foundation for envisioning curriculum spaces in STEAM-based mathematics education **(See Chapter IV**). Participatory future studies have inspired me to envision inclusive, co-created futures (Ollenburg, 2019). This methodology further solidifies my dedication to participatory research, which honors the perspectives of all stakeholders and enhances educational discourse and practice. My understanding of the transformative potential of education is furthered by these theoretical frameworks, which also inform my methodological decisions. Dynamic forces that interact with and influence the lived experiences of myself, my participants, and my critical friend, rather than static constructs, are what they are. In my reflections and writing, these theoretical referents and perspectives establish a strong foundation for reimagining school mathematics, aiming to achieve a future in which education is transformative, empowering, and liberating. As part of the inquiry, I extend an invitation to readers to participate in this collective exploration and transformation journey.

Reflection on My Inclusive Methodological Choices

While reflecting on my methodological roadmap as a researcher in my PhD journey, I wrestled with different methodological designs, which are the testament in my various publications (e.g., Dahal, 2023a, 2023b, 2023c; Dahal, 2024a, 2024b, to name but a few). However, I began with auto/ethnography inquiry, then collaborative autoethnography, again auto/ethnography inquiry, and finally landed on the Swa-Twam-Tat inquiry as an alternative research methodology that is proposed to integrate the individual self (Swa), relational selves (Twam—research participants and a critical friend), and universal self (Tat—readers) and beyond. This shift in methodological choices was a basic tenet of my inquiry, expressed in the following box in the poetic form. As I sought methodological contribution in my PhD thesis, I subscribe to the Estarern Gyāna Pranāli design space. Likewise, I have to make this decision primarily because of the availability of my research participants for prolonged engagement as a participatory researcher to find common and uncommon views and perspectives.

As expressed in poetic form in the adjoining text box, although my journey has enabled me to investigate the complexities of STEAM-based mathematics education, drawing on my personal lived experiences in alignment with the critical friend and research participants, I am consequently inviting the readers within(out) the community of 'I.' I aimed to critically evaluate the existing pedagogical frameworks and promote transformative educational practices by adopting Bahuprasnavāda, thereby helping me to reflect deeply on my identity and role as a STEAM educator and researcher, urging me to envision and strive for deep democracy within educational structures. In the same vein, Bahurūpavāda Gyāna Parnāli provided expressive avenues for the representation of a wide range of emotions and thoughts, thereby enriching my inquiry with a diverse array of genres and forms of logic. Adding depth and plurality to my inquiry, Parnali provided the tools necessary to capture the ineffable and subjective realities of educational experiences. I was able to closely observe human behaviors and interactions through Bahuarthavāda Gyāna Parnāli, which are essential for comprehending the complex realities of educational environments. This method taught the significance of context and enabled me to produce insightful interpretations of intricate educational phenomena. Prajyanvāda Gyāna Parnāli completed my methodological approach by offering a comprehensive perspective on education. It allowed me to integrate theories and perspectives, thereby fostering a comprehensive comprehension of educational practices and enabling me to envision transformative changes (Schmeller & Bridgewater, 2023). This methodological journey has expanded my academic horizons and facilitated my personal development as a researcher and educator who adheres to the Eastern Gyāna Pranāli. I have been able to develop a comprehensive, multifaceted understanding of the educational landscape within the Gyāna Pranāli of Bahuprasnavāda, Bahurūpavāda, Bahuarthavāda, and

I danced with doubts in shifting light.
Bahuprasnavāda sparked the fight.
Bahurūpavāda gave form to feelings.
Bahuarthavāda made context illuminative.
Prājyanvāda wove the threads—
Of self, of world, of truths unsaid.

Prājyanvāda design space. Thus, this journey has served as the foundation for my professional and personal growth as a researcher.

Responding to My Research Questions

Chapter IV of my thesis attempted to respond to my **first research question**—*how have mathematical curricular spaces been developed via the synergy of local and global knowledge for producing innovators?* I explored the dynamics of mathematical curricular spaces, drawing on my experiences as a student, educator, teacher trainer, and STEAM scholar. The inspiration drawn from "Mathematics Curriculum Spaces for Pedagogical Change, Learning Mathematics as Experience: Exploring Mathematics Classrooms, Designing a Mathematics Unit Around Interest, Creating Mathematics Problem Scenarios, Connection to Local and Global (i.e. Glocal) Knowledge Systems in Mathematics, Trans/disciplinary Teaching across Mathematics, Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections, Tat Inquiry: Third Person 'Universal' Insights and Reflections." This reflective journey illuminated through the lens of transformative learning theory, knowledge-constitutive interests, and critical pedagogy guides my exploration of how local and global knowledge synergistically inform curricular frameworks to cultivate innovators in mathematics. Through lived experiences with various stakeholders—students, fellow educators, and academic peers—I have uncovered the intricate tapestry of school mathematics that blends rigorous academic content with culturally resonant practices. My experiences ensure the role of curriculum spaces that are not merely repositories of knowledge but active and dynamic, where pedagogical strategies and content enhance learner engagement and creativity. Chapter V concludes my journey, where personal narratives and academic inquiry intersect to challenge and expand traditional curriculum design and space notions. With personal anecdotes and empirical research, I offer a nuanced perspective on the transformative potential of educational spaces that harness both local insights and global perspectives. This reflection addresses my second research question and reinforces my commitment to educational reform. It offers a shift from viewing curriculum as a static set of guidelines to seeing it as a vibrant, interactive framework capable of fostering deep, meaningful learning and innovation in school mathematics, subscribing to Schubert's curriculum images and Paulo Freire's stages of status quo, sensitization, and conscientization, the transformative model emphasizes informing, reforming, and transforming, aligning with technical, practical, and emancipatory curriculum interests and a Swaraj perspective of the shared and autonomous models.

While responding to my **second research question**— *how are engaged pedagogical processes practiced and envisioned in the school mathematics classroom?* - I explored a reflective journey through my research. The fundamental question I sought to address was the role of school-community collaboration in fostering an engaged pedagogy for mathematics education. Responding to research question 1 in Chapter IV, my introspections and dialogues with research participants and a critical friend within the framework of Swa-Twam-Tat (meaning individual self, relational selves, and universal self) highlighted a glowing picture of traditional pedagogies and their transformation towards more engaged, student-centric approaches. The inspiration is drawn from “Engaged Pedagogy as a Dialectical and Multidimensional Space, Purposeful Practices of Engaged Pedagogies, Home Visits as/for Engaged Pedagogy, Engaged Pedagogy via Parents Engagements in School Events, Expanding the Sphere of Engaged Pedagogy: Guest Lecture from Parents, Parent-Teacher Meeting as Promoting Engaged Pedagogy, Math Club as Promoting Engaged Pedagogy, Engaged Pedagogy in School Mathematics: What Is to Be Included (or Not)?, Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections, Tat Inquiry: Third-Person ‘Universal’ Insights, Theoretical Synthesis: Engaged Pedagogy as a Dialectical Space.” As I viewed educational practices through the lenses of engaged pedagogy, I explored the effectiveness of hands-on activities, real-world problem-solving, and cooperative learning. Each of these methods promised a more relatable and stimulating school mathematics, steering students away from mere recipients of information to becoming active participants in their learning landscapes. My reflections, grounded in transformative learning theory, critical pedagogy, knowledge-constitutive interests, curriculum images and metaphors, and the Swaraj perspective, allowed me to evaluate and challenge prevailing educational norms. This theoretical and perspective backdrop informed my understanding and shaped my practical classroom and community interventions. The engaged pedagogies I explored and implemented have demonstrated the potential for school mathematics reform by enhancing students' problem-solving and critical thinking skills while sparking their intrinsic interest in the subject. Through the process of engaging with students, teachers, and community members, I found that the shift towards engaged pedagogies is not merely an educational reform but a cultural shift toward making learning a more inclusive, collaborative, and transformative experience. The role of community in this educational paradigm proved to be essential, as it bridged the gap between academic theories and practical, real-world applications. My research question reaffirmed that engaged pedagogy is not just a method but a movement toward rethinking how we teach and learn mathematics in school. It is a call to educators to transform traditional classrooms into vibrant learning communities that encourage curiosity, critical thinking, and a deep understanding of mathematics through collaborative and contextual learning. The journey explored in Chapter IV has responded to my research questions and also set the stage for ongoing exploration into how we can continuously improve and innovate in school mathematics.

Chapter VI attempted to respond to **my third research question**: In what ways have change-driven teacher professional development initiatives around school mathematics education been inclusive of *both local and global perspectives?* The themes covered in Chapter VI are "Professional Development in School Mathematics, Synergy Between Local and Global Perspectives of PD, Key to Implementing PD: Remixing Education, Professional Development for Educational Change, Reflections on Evolving Vision of Teacher PD, followed by Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections and Tat Inquiry: Third-Person 'Universal' Insights and Reflections". Reflecting on the professional development initiatives around school mathematics, as detailed in Chapter VI, as a Swa-Twam-Tat inquirer, my personal and professional experiences across various roles—as a student, teacher, teacher trainer, and STEAM scholar—inform my insights into the effectiveness and inclusiveness of these initiatives. From my involvement in over 200 professional development sessions, spanning pre-primary to university levels across Nepal and India, I have noted that while many efforts aim to integrate innovative teaching practices and cutting-edge strategies, the actual outcomes often fall short of creating sustainable change. This discrepancy is common in traditional teaching methods, and there is a lack of long-term support for teachers implementing new and innovative strategies. Thus, in my inquiry, the idea of TPD has been discussed from three approaches: informing (teaching teachers and running sessions), reforming (collaborating with teachers), and transforming (using critical reflection and creative methods), guided by questions from Freire: How do teachers connect outside and inside the classroom? Habermas: How do teachers use reflection to develop authentic insight? Mezirow: How do they integrate differing viewpoints to resolve teacher dilemmas? And Gandhi: How do they connect them with students' selves? How do they incorporate participatory future studies (Ollenburg, 2019)? I argued for a shift towards more inclusive and contextually responsive professional development. This shift encompasses new teaching strategies but also fosters an environment of continuous learning that truly empowers teachers. For instance, I have added examples of the community-based initiatives by CPEC and KUSOED that have been vital in promoting problem-solving and interactive learning over rote memorization by connecting the university to the community and the community to the university, which is a significant advancement in our pedagogical approach. My inquiry explored the importance of aligning professional development with both local and global educational standards while ensuring it is rooted in the practical, day-to-day challenges teachers face.

Chapter VII of my thesis attempted to respond to my **fourth and final research question**—*how has the leadership development process (teachers as change agents) been in place in areas of school mathematics education?*- based on the themes “A New Beginning as a Full-Time Mathematics Teacher, Becoming a Community Facilitator of Mathematics, Immersing in the Leadership Development Process, Leadership Development Process in Mathematics Education, Moving Forward with Leadership Development Process in Mathematics Education, Concluding Thoughts and Evolving Vision of the Leadership Development Process, Swa Inquiry: First-Person Reflections, Twam Inquiry: Second-Person Relational Reflections, Tat Inquiry: Third-Person ‘Universal’ Insights and Reflections.” In Chapter VII, I explored the evolving landscape of my leadership role and leadership process within the context of school mathematics, subscribing to the theoretical referents and perspectives of critical pedagogy (Freire, 1970), knowledge constitutive interests (Habermas, 1972), transformative learning (Mezirow, 2000), and Swaraj's perspectives (Gandhi, 1909). My journey from the various stages of my career—from a part-time mathematics teacher to a community facilitator and, finally, a researcher—highlighted the transformation in my professional identity and pedagogical practices. Reflecting on my leadership role has been a cornerstone of understanding how leadership in school mathematics shall fundamentally shift the learning outcomes and overall school achievements—teacher professional learning, teaching practice, and student learning outcomes (Meiers, 2007). The insights I gathered, articulated through personal narratives and supported by theoretical frameworks such as Mezirow's transformative learning and Freire's critical pedagogy, reveal the relationship between leadership roles and the leadership development process and students' achievement in school mathematics. My initial days as a full-time teacher were marked by a quest for stability and recognition within the school community, which gradually shifted to nurturing another mathematics teacher as a community facilitator. This transition was merely a change in roles and a shift in perspective, where leadership entailed fostering a collective vision and driving pedagogical innovations. The leadership narratives I explored—ranging from facilitating professional development sessions to leading transformative initiatives (Ruchti et al., 2018)—explore the significance of a leadership development process in school mathematics. This process is not linear but dynamic, continuously influenced by personal experiences, community interactions, and theoretical insights. Finally, my reflections in Chapter VII serve as a transformative power of leadership in education. As I narrated my journey and the journeys of others, it became evident that effective leadership is crucial for inspiring change and fostering an environment conducive to significant educational reforms in school mathematics. Through this inquiry, I not only responded to the emerging research question about the nature of leadership development in school mathematics but also connected deeply with the broader implications of such leadership for the educational communities.

Learning from Writing, Publications, and Peer Review Processes

So far in my PhD journey, I have published 71 plus articles (**See Appendix II**). These include research articles, commentaries, editorials, book reviews, research notes, book chapters, and conference proceedings. At this stage, I feel somewhat vulnerable when sharing my publication profile. Yet, behind this vulnerability lie numerous success stories of learning, connecting ideas, and crafting writings and publications that deserve to be heard.

As a Ph.D. scholar in STEAM education in Nepal, I have found immense value in learning from my publications. Likewise, my academic profiles[17] serve as both the foundation and the outcomes of my PhD engagements expressed in the poetic form in the box text below. The continuous process of learning from publications from 2020 to 2024 has shaped my academic pursuits and empowered me to contribute meaningfully to the advancement of STEAM education in Nepal. Likewise, these publications serve as a rich source of knowledge, offering insights into the latest research and advancements in the STEAM educational field. Each published article broadens my understanding, equipping me with new perspectives while envisioning transformative STEAM-based mathematics education in Nepal that approaches my quality engagement to produce an authentic thesis. Likewise, the variations of ideas in these publications stimulate my intellectual curiosity, driving me to explore beyond the conventional boundaries of STEAM education. Despite the challenges of limited resources and accessibility, these publications bridge the gap, connecting me to the global community of practice and fostering a culture of continuous learning. Serving as an editorial board member for journals such as The Qualitative Report, Advances in Mobile Learning Educational Research, Frontiers in Education, and the Journal of Hypermedia & Technology-Enhanced Learning (to name but a few) has significantly shaped my academic activities. This ongoing learning process has empowered me to contribute while envisioning transformative STEAM-based mathematics for Nepal.

> Seventy-one plus publications,
> a journey embracing humility and criticality,
> Perhaps there is more un/knowing
> Through writing and reviews, new insights were found.
> Each article crafted, each critique received,
> Un/refined my work, and my purpose was conceived.
> In vision of STEAM education, I now un/clearly see,
> A future for Nepal, where learning is un/free.

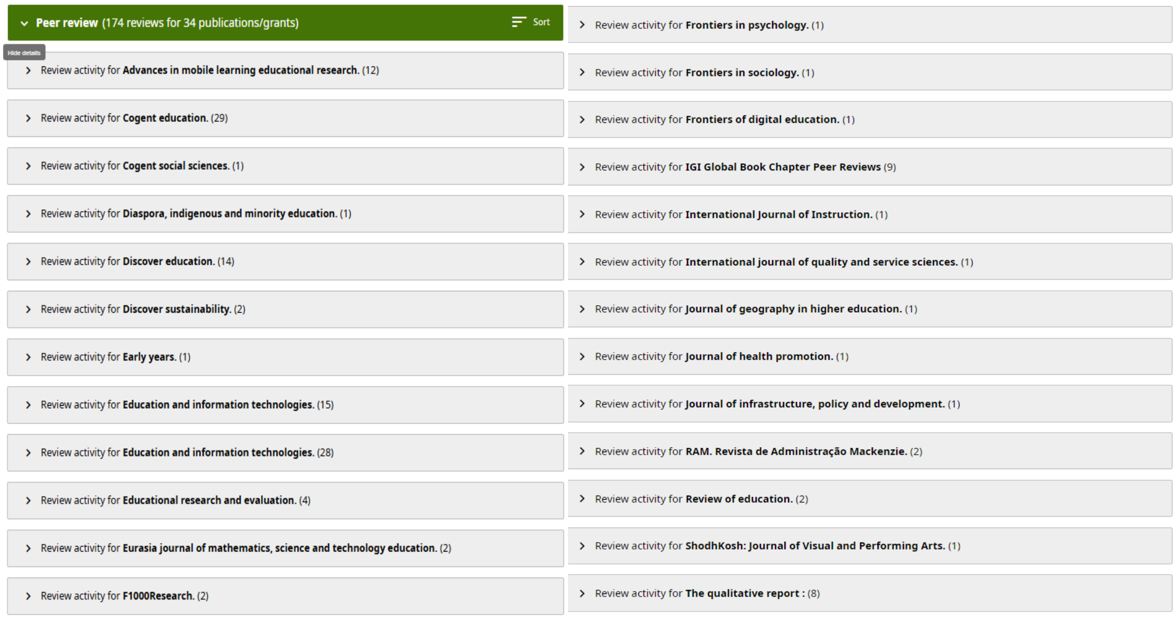
Likewise, as a PhD scholar, learning from peer reviews of national and international journals and publication presses was invaluable in my academic career. Peer review engagements provided me with critical feedback that helped refine my work, ensuring I met high standards of quality and rigor. By engaging with these

[17] Google Scholar: https://scholar.google.com/citations?user=BzcPJKEAAAAJ&hl=en&oi=ao
ORCID: https://orcid.org/0000-0001-7646-1186
Scopus: https://www.scopus.com/authid/detail.uri?authorId=57210440609
AD Scientific Index: https://www.adscientificindex.com/scientist/niroj-dahal/5294412,
Loop: https://loop.frontiersin.org/people/1718506/overview

reviews, I have identified gaps in my methodology (See Chapter III), enhanced my arguments, and improved the clarity and impact of my writing. Further, I understood that the perspectives of diverse authors from different regions and disciplines foster a more comprehensive and nuanced approach to research. This iterative process of receiving and incorporating feedback helped me elevate my studies and contributed to advancing knowledge within the academic community. Next, during my PhD, I reviewed more than 150 articles worldwide, ranging from general education to STEAM education. Figure 16 below shows my recorded reviews of different journals and publication presses.

Figure 16

My Engagements in Peer Review Processes



(Source: Screenshot on December 25, 2024, https://orcid.org/0000-0001-7646-1186)

Thus, continuously engaging in writing, publishing, and peer reviews has provided me with the foundation for developing the vision for STEAM-based mathematics education in Nepal.

Novelty and Level of Contribution of My Inquiry

Though I reported my inquiry based on my PhD journey, which started in February 2020, the foundation was from my master's and MPhil studies. However, I have been through different stages of my research journey while unfolding my meaningful journey. So, I believe my inquiry will be able to unearth based on the overarching research question, what contextual and universal perspectives contribute to developing a vision of transformative STEAM education in Nepal? It focuses on relations between the school and the community in developing an engaged educational process across the school mathematics and technology education aligned to the poetic expression in the adjoining text box. The notion behind developing an engaged educational process in my inquiry into STEAM-based mathematics education is to probe the pedagogical process and leadership development process of mathematics teachers in the schools, and how they are conceived and implemented for producing innovative thinkers. I will further investigate the teacher's professional development initiatives around school mathematics and technology education, which have been responsive to local and global technologies. I hope that my inquiry will synergize local and global knowledge systems in creating curricular spaces across mathematics and technology education.

> Self meets system, local learns global,
> Praxis breathes through classrooms—lively, noble.
> Context shapes dreams, and reflection fuels action,
> STEAM leads forward: grounded, exact.
> Thesis dances with antithesis, yielding synthesis—
> Hope meets critique, tension births praxis.

Also, other—novice, veteran, or seasonal researchers shall benefit by learning the process of my Swa-Twam-Tat inquiry and knowing my underpinned standpoints aligned with theoretical referents, namely transformative learning theory (Mezirow, 1991), knowledge constitute interests (Habermas, 1972), critical pedagogy (Freire, 1970), Swaraj perspective (Gandhi, 1909) and participatory future studies (Ollenburg, 2019) and metaphoric representational approach which allow every researcher to be emergent about their research approach and engagements.

How is my Inquiry Associated with the National Priority?

As I am approaching the final step of my doctoral journey, my inquiry, "Developing a Vision for STEAM-based Mathematics Education in Nepal: An Swa-Twam-Tat Inquiry," aligns directly with national priorities. The local, provincial, and central governments are also implementing different forms of STEAM education with some support from the INGOs, NGOs, or with their own budgets. Many STEM/STEAM-related activities are conducted in teacher professional development sessions. STEAM education policies can be read and are available in the public domain, developed by local, provincial, and central governments (Dahal, 2022b).

STEAM education is a focal point in educational policies, with local, provincial, and central governments in Nepal working on reforms to the existing curriculum, pedagogy, and assessment by integrating these STEAM approaches in their curricula. This inquiry aimed to envision STEAM-based mathematics education in Nepal in school and school community involvement in developing an engaged pedagogical process in the school mathematics classroom, curricular spaces, teacher professional development initiatives around school mathematics education, and leadership development processes of school mathematics education. This Swa-Twam-Tat inquiry aimed to contribute to developing STEAM-based mathematics education by exploring several key areas. These include the relationship between schools and communities in fostering an engaged educational process, the pedagogical methods designed and implemented to produce innovators, teacher professional development, leadership development processes, and the synergy between local and global knowledge systems. Thus, this inquiry will help develop both contextual and universal perspectives on STEAM-based mathematics education in Nepal.

STEAM-Based Mathematics Education in Nepal: An Envisioning Model

The purpose model of my inquiry into the transformative STEAM-based mathematics education for Nepal is based on my integration of empirical chapters (IV-VIII), theoretical referents, and perspectives.

Figure 17

STEAM-based Mathematics Education in Nepal

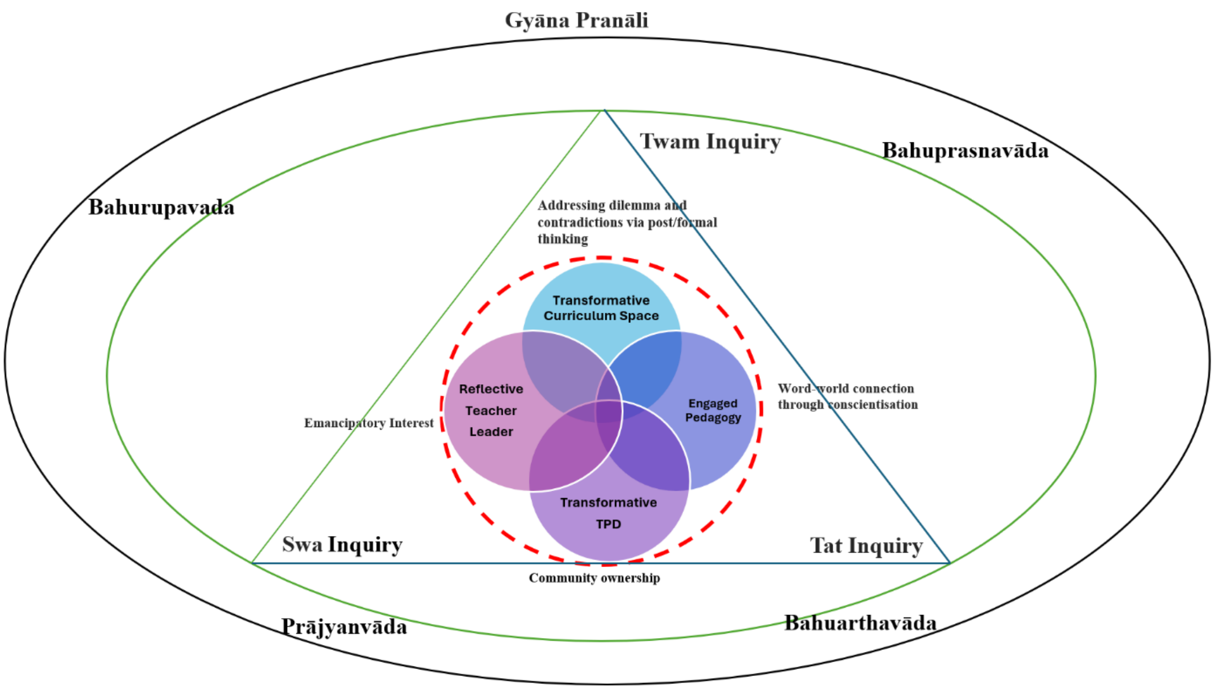


Figure 17 illustrates the model of the "Gyāna Pranāli" (i.e., knowledge system) design space of my inquiry, which envisions the STEAM-based Mathematics

Education in Nepal integrating Eastern philosophical traditions with critical social theories and pedagogical models. Further, transformative learning theory (Mezirow, 1991), Habermas's concept of knowledge-constitutive interests (1972), Freire's critical pedagogy (1970), Gandhi's Swaraj perspective (1909), curriculum images (Schubert, 1986), and participatory future studies (Ollenburg, 2019) are theoretical referents and perspectives of this model. Likewise, the four interconnected dimensions of Gyāna Pranāli design space—Bahuprasnavāda, Bahuarthavāda, Bāhurupavada, and Prājyanvāda are viewed from the Swa-Twam-Tat inquiry as dialectical approaches. The first dimension, Swa Inquiry, focuses on introspection and wisdom, urging educators and learners to develop self-awareness and incorporate knowledge into their personal and ethical practices. The second dimension, Twam Inquiry, aims at systemic transformation in mathematics education. The final dimension, Tat Inquiry, emphasizes critical inquiry and pluralism, encouraging exploring fundamental truths and accepting diverse interpretations and perspectives. All of the above, a dualistic approach as relational selves that resolves contradictions through poststructuralist thought; a transformative curriculum space that re-envisions curricula as fluid and inclusive; the role of educators as reflective teacher leaders who lead with critical self-awareness; transformative teacher professional development (TPD) to foster innovation; and community ownership, ensuring that local communities actively shape educational practices. Likewise, prioritizing critical inquiry and pluralism, emphasizing a word-world connection, grounding language in lived experiences through conscientization—a concept by Freire (1970) that fosters vital consciousness exploring fundamental truths ("Tat" meaning "That”), embracing diverse interpretations and perspectives.

Thus, Gyāna Pranāli design space synthesizes Eastern philosophical tenets—such as self-reflection, pluralism, and the pursuit of truth—with modern educational paradigms like transformative pedagogy and critical theory. This model advocates for a comprehensive approach where systemic reform, critical questioning, and personal enlightenment coexist, striving to establish equitable, dynamic, and wisdom-centered learning environments in Nepal and beyond.

Limitations of Swa-Twam-Tat Inquiry

The nature of my Swa-Twam-Tat inquiry was confined to the individual self (Swa) across four research participants and a critical friend (Twam as relational selves) by inviting the readers (Tat as universal self), but the filed texts, narratives, voices, and reflective notes span from my early career as a novice mathematics teacher to STEAM professional. So, in my inquiry, there were two types of field texts, narratives, voices, and reflective notes: collected from February 2020 to February 2024 through interviews and focus group discussions, and generated from my master's study to my PhD study. My conversations with my research participants and a critical friend were primarily based on the generated field texts, narratives, reflective notes, and interview questions (**See Appendix I**) as vāda interviews (Gubrium & Holstein, 2003). Vāda interviews explored the tradition of debate and dialogue, aiming to reach correct knowledge through discussions. Likewise, the field texts, narratives, and reflective notes were derived from my lived experiences as a mathematics teacher, encompassing MPhil and PhD scholar. This includes insights gathered before, during, and after my fieldwork engagements. To interpret and make meaning of the field texts, narratives, voices, and reflective notes, I utilized Ākhyāna writing as the process of inquiry, incorporating three distinct perspectives of the Swa-Twam-Tat inquiry (Dahal et al., 2024a):

1. First-person inquiry (Swa): Through journaling, introspection, and autoethnography, I reflected on my personal experiences and inner thoughts.
2. Second-person inquiry (Twam): I engaged in interviews, focus groups, and collaborative sharing to explore interpersonal dynamics and collective insights.
3. Third-person inquiry (Tat): I examined broader contexts using ethnography, field texts, comparative studies, and document analysis to capture universal and contextual perspectives.

This multi-layered approach allowed me to integrate both individual and collective dimensions of the inquiry, expressed in the following play on the next page. Over the course of more than two years of fieldwork, I systematically collected and analyzed the data to ensure a comprehensive understanding of the subject.

Final Remarks: What Have I Expected? Where am I now?

For this inquiry, while drafting my proposal, I was planning to develop four empirical research articles for publication while developing a vision for STEAM-based mathematics education in Nepal for citizenship education. In terms of planning, my first research article will contribute largely to how relations between the school and school community are developing an engaged pedagogical process in the school mathematics classroom. The second research article will explore how mathematical curricular spaces have been developed via local and global knowledge synergy to produce innovators. The third research article will explore—in what ways have change-driven teacher professional development initiatives around school mathematics education have been inclusive to both *local* and global perspectives. The fourth research article will explore how the leadership development process (teachers as change agents) has been in place in areas of school mathematics education. This was planned based on my four subsidiary research questions that ultimately offer me the opportunity to develop a vision of contextual and universal perspectives and contribute to developing transformative STEAM-based mathematics education in Nepal.

As a Ph.D. scholar specializing in STEAM education in Nepal, my PhD journey started in February 2020. During the PhD journey, I exceeded my plan of writing and publication more than 18 times and published more than 71 different types of articles (See Appendix II). These 71-plus publications were research articles, commentaries, book chapters, book reviews, reviews, editorials, and conference proceedings expressed in the poetic form in the adjoining box text. As an ongoing and futuristic researcher, this milestone was not on my radar, but I have come to this stage and do not know the future. However, I find immense value in reflecting on my publications. While sharing my publication profile at this stage makes me feel vulnerable, each publication represents a unique journey of discovery, collaboration, and growth that connects ideas. With these experiences, I hope to inspire and contribute to broader academic communities in the scholarship.

> With self as knower, I dared to inquire,
> Kindling context with a scholar's fire.
> Society spoke through voices near,
> Their hopes and struggles are drawing.
> Theory met praxis in every thread.
> As a local and global knowledge fair.
>
> I questioned power, I questioned place,
> I walked with doubt—and still with
> grace. For each reflection, I turned the
> key. To what it means to truly be a
> teacher, leader, citizen, or friend,
> whose journey learns and never ends.

This Swa-Twam-Tat inquiry covered a broad spectrum of reflective and transformative STEAM-based mathematics education for myself, teacher educators, curriculum developers, educational researchers, school leaders, policymakers, social actors, and other community members. In so doing, it signifies philosophical significance, practical significance, curricular significance, pedagogical significance,

significance for professional development, teacher education, knowledge production, social impact, and significance for assessment. Likewise, to signify the importance of my inquiry, I have used reconceptualizing self-metaphors (McVicker & Walker, 2020), which helped me create ample opportunity to develop myself as a transformative STEAM-based teacher educator and a futuristic educational leader who could contribute to cultivating citizenship education. Next, I was aware of my role while collecting, generating, and reflecting on the field texts, narratives, voices, and reflective notes. Abiding by ethos— filed texts, narratives, voices, and reflective notes is everywhere as the process of telling and retelling the story of my transformative praxis (Dahal et al., 2022; Luitel & Dahal, 2020) contributes to my professional growth. And praxis helps me to raise the consciousness of myself, research participants, a critical friend, and social actors through a constant embracing of a critical stance towards text (largely for myself), discourse, and the lifeworld to engage in the process of holistic meaning-making (Luitel & Dahal, 2020) of my meaningful PhD journey within in community of 'I'.

Further, my inquiry will help teacher educators in Nepal (but not limited to) develop contextual and universal perspectives of transformative STEAM-based mathematics education. My inquiry may encourage them to look into their transformative praxis to empower teacher educators and other stakeholders. Largely, through my inquiry product and generated texts, empowerment in my inquiry will draw upon the ongoing discourse of an emancipatory interest emphasizing autonomy, responsibility, and criticality. My doctoral journey, I would say, was a new beginning. Yet, there are more areas to explore and reflect on in STEAM education. This journey is not the end but the beginning of yet another opportunity. So, I am always keen to share my Swa-Twam-Tat inquiry process and key learning with research participants, a critical friend, seniors, policymakers, and research scholars—novice and veteran. This meaningful and transformative journey would help enrich knowledge on further conceptualizing STEAM-based mathematics education and STEAM education for nurturing citizenship education.

As I reflected on the overall learning and inquiry process, I recognized the STEAM approach as a comprehensive and integrated method for teaching and learning. This approach emphasizes context, interdisciplinary connections, and diverse learning styles while ensuring equitable participation among learners. STEAM fosters a dynamic and inclusive educational environment, whether applied in classroom mathematics instruction or project-based assignments. As a PhD scholar and practitioner-researcher in STEAM Education, this inquiry aims to spark meaningful dialogue among mathematics teachers, department heads, and policymakers. It seeks to encourage the integration of diverse concepts and promote professionalism in teaching and facilitating mathematical concepts, ultimately enhancing the quality of education.

Ways Forward: Starting Afresh

This Swa-Twam-Tat inquiry explored the reflections and revelations of my meaningful journey as a STEAM scholar while envisioning STEAM-based mathematics education in/for Nepal for citizenship education as a poetic expression in the box text on the next page. Swa-Twam-Tat inquiry enabled my authentic "experiences to be brought into the light so that they can be discussed and better understood" (Smit & Fritz, 2008, p. 100) of the phenomena for their possible actions and reactions. Likewise, the concept of the inquiry challenged the Western-induced perspective of dualism, which separates the autoethnographic self (I, first-person) from culture (other, third person). In my inquiry, I employed the I-thou-other approach within our non/dual (partly dual and wholly nondual) context of the three-fold classifications of persons. Swa (individual self) represented myself as both a practitioner and researcher. Twam (thou or you as relational selves) refers to the intermediary space between self and other, acting as a connector or mediator. In this context, Twam included my participants and the critical friend who engaged with me and maintained an I-thou relationship during the inquiry process. Tat (universal self) signified the other, which may not have been directly known but referred to readers and distant critics of my work. However, the blurred relationships between I, thou, and others were recognized. I represented Swa, claiming ownership and authorship of my texts. Simultaneously, as Twam, I engaged in dialogue with my researcher self as a practitioner self, questioning how this methodology worked in practice. As Tat, I became a reader beyond my authorly spectrum, questioning why my authorly self-researched and wrote this way. In the years following this inquiry, as my consciousness evolved, I conversed with my authorly texts and questioned why the researcher could not have done otherwise. This was achieved by Twam (another

This inquiry invites dialectical stances—Swa (self), Twam (relational selves), and Tat (universal self)—to reimagine STEAM-based mathematics education through reflection, dialogue, critique, and transformation for inclusive citizenship education.

self, connected with the first person) and Tat (the third person, who treated the text as and through distance).

On the other side, throughout my PhD journey and even before, I have authored over two dozen autoethnographies aligned to the Swa-Twam-Tat inquiry (e.g., Dahal, 2013, 2024; Dahal & Luitel, 2022, 2023; Dahal et al., 2019a; Dahal et al., 2022; Luitel & Dahal, 2021; Paudel et al., 2023). These works span a range of topics, from personal well-being, traveling, and healing to professional development. My engagement with a solo autoethnographic inquiry aligned with Swa began during my master's research in mathematics education (Dahal, 2013). So, as per my understanding, Swa-Twam-Tat inquiry underpins the conceptual, philosophical, and etymological origins that intersect with my transformation based on the different forms of the narratives of meaningful journeys while developing a vision of STEAM-based mathematics education with the community of 'I.'

In my inquiry, I drew upon several theoretical referents to establish the foundation for envisioning a dynamic and evolving approach to STEAM-based mathematics. These referents include transformative learning theory (Mezirow, 1991), knowledge-constitutive interests (Habermas, 1972), critical pedagogy (Freire, 1970), curriculum images and metaphors (Schubert, 1986), the Swaraj perspective (Gandhi, 1909), and participatory future studies (Ollenburg, 2019). Together, they provided the theoretical roots and underpinnings necessary to conceptualize STEAM-based mathematics as a fluid and ongoing process relevant to both personal and professional growth.

I have faced numerous challenges and uncertainties throughout my professional journey as a STEAM scholar. These struggles, however, are not unique to me; they are shared by many mathematics teachers and educators who strive to advocate for change in their pedagogical approaches to foster creativity and innovation. This inquiry aims to support my vision for STEAM-based mathematics by addressing four key areas for nurturing citizenship education:

1. The relationship between schools and their communities in fostering an engaged and participatory pedagogical process for teaching mathematics.
2. The integration of local and global knowledge within mathematical curricula to cultivate future innovators.
3. Initiatives for teacher professional development focused on enhancing school mathematics education.

4. Leadership development processes: the role of teachers as change agents in advancing school mathematics education.

This inquiry seeks to contribute to a transformative vision of STEAM-based mathematics that is both innovative and responsive to the needs of educators and learners alike by exploring these dimensions.

So, I would say ……………

……………. The journey begins from here!

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APPENDIX I
THEMATIC QUESTIONS FOR INITIATING DISCUSSIONS IN MY INQUIRY

Thematic Areas

1. Pedagogical Engagement for Engaged Pedagogical Processes in Mathematics
2. Mathematical Curriculum Spaces: Synergy of Local and Global Knowledge for Producing Innovators
3. Teachers' Professional Development Initiatives Around School Mathematics
4. School Mathematics Leadership Development Processes

Pedagogical Engagement for Engaged Pedagogical Processes in Mathematics

- Can you share a personal story or experience that aligns with the relationship between the school and the community in the context of teaching mathematics?
- How do you believe community involvement in school mathematics has evolved based on your personal and professional experiences?
- What are the most significant challenges and successes you have encountered in engaging the community with school mathematics?

Mathematical Curriculum Spaces: Synergy of Local and Global Knowledge for Producing Innovators

- Could you describe an instance where local knowledge significantly influenced the mathematical curriculum in your school or area?
- How do you integrate global mathematical concepts with local practices? Please share specific examples or stories.
- What opportunities do you see for enhancing the mathematical curriculum by combining local and global perspectives?

Teachers' Professional Development Initiatives Around School Mathematics

- Reflect on a professional development session that affected your approach to teaching mathematics. What changed for you?
- What gaps do you see in the current professional development offerings for mathematics teachers at your school?

- How do you personally keep up with the evolving demands of teaching mathematics?

School Mathematics Leadership Development Processes

- Can you share your journey or a significant experience that shaped you as a leader in school mathematics?
- What qualities do you think are essential for effective leadership in school mathematics, and how do you foster them in your role?
- How do you assess and address the leadership development needs of your mathematics department?

APPENDIX II

LIST OF PUBLICATIONS FROM 2020-2025

S.N.	Article Title	Types of Publication	Rank	Year	Role as author	Remarks
1	Integration of GeoGebra in Teaching and Learning Geometric Transformation	Article		2020	First and corresponding author	Area of Interest
2	Conceptualizing Transformative Praxis	Editorial		2020	Second author	PhD issue
3	Emerging ICT Tools, Techniques and Methodologies for Online Collaborative Teaching and Learning Mathematics	Article		2021	First and corresponding author	PhD issue
4	Exploring Project-Based Teaching for Engaging Students' Mathematical Learning	Article		2021	Second author	Area of Interest
5	Workshop Activity in	Proceeding of ICME-14		2021	Single author	Area of Interest

	Online Courses of Mathematics Education: Insights for Learning and Assessment					
6	Autoethnography: Writing lives and telling stories	Editorial		2021	Second Author	Foundation for PhD reading and writing
7	Understanding and Encountering the Ethics of Self and Others in Autoethnography: Challenging the Extant and Exploring Possibilities	Article	Scopus Q1 and Web of Science Q2	2022	First and corresponding author	PhD Qualifying Paper I
8	Transformative STEAM Education as a Praxis-Driven Orientation	Article		2022	Single author	PhD Qualifying Paper II
9	Possibilities of a Participatory Pedagogy for Enhancing Teaching, Learning and Assessing in a Nepali University Class	Article		2022	Third author	Area of Interest

10	Use of GeoGebra in Teaching and Learning Geometric Transformation in School Mathematics	Article	Scopus Q3	2022	First and corresponding author	PhD issue
11	The Learning Performance of Indigenous Students in Nepali Private Schools: A Mixed-Methods Study	Article	Scopus Q2 and Web of Science Q2	2022	Third and corresponding author	Area of interest
12	Narratives of Nepali school mathematics teachers on classroom questioning techniques	Article		2022	Single author	Area of interest
13	Enhancing student-teachers' assessment skills: A self-and peer-assessment tool in higher education	Article	Scopus Q3	2022	First and corresponding author	PhD issue
14	Exploration of the Workshop activity for peer assessment in	Article		2022	First and corresponding author	PhD issue

	online courses of mathematics					
15	Mathematics Pedagogies and Assessment Practices in Semester System at Tribhuvan University	Article		2022	Fourth and corresponding author	Area of interest
16	Engaged Mathematics Learning as/for a Transformative Praxis	Editorial		2022	Second author	PhD issue
17	Pedagogy for Blended Learning: Ensuring Higher Learning Outcomes	Book chapter		2022	Second author	Area of interest
18	GeoGebra Integration in High School Mathematics: An Experiential Exploration on Concepts of Circle	Article	Scopus Q4	2022	Second and corresponding author	Area of interest
19	STEAM Education for School Teachers in Nepal	Conference proceeding		2022	Fourth author	PhD issue
20	The Nature of	Conference		2022	Fifth author	PhD issue

	Multi-, Inter-, Trans-Disciplinary STEAM Education Curriculum in Nepal	proceeding			
21	ICT tools for remote teaching and learning mathematics: A proposal for autonomy and engagements	Article	2022	First and corresponding author	Area of interest
22	Critical pedagogy: Future and hope	Editorial	2022	Second author	PhD issue
23	ICTs into mathematical instructions for meaningful teaching and learning	Article	2022	Second and corresponding author	Area of interest
24	Understanding and uses of collaborative tools for online courses in higher education	Article	2022	Single author	Area of interest
25	Autoethnography: Bringing Lives and Research Together	Conference proceeding	2022	First and corresponding author	PhD issue

26	Is doing research for people or on people? A book review of Emancipatory and Participatory Research for Emerging Educational Researchers: Theory and Case Studies of Research in Disabled Communities	Book review	Web of Science Q2	2023	Single Author	Area of Interest
27	Use of GeoGebra in High School Mathematics: A Case of Geometric Transformation for Teaching and Learning	Book Chapter		2023	First and corresponding author	Area of interest
28	Using digital stories during COVID-19 to enhance early-grade learners' language skills	Article		2023	Second and corresponding author	Area of interest
29	Journey of Realization and Adaptation through	Article	Scopus Q1 and Web of Science	2023	Third author	Area of interest

	Auto/Ethnography: A Shift to Transformative Educational Research		Q2			
30	Teaching-learning practices of mathematics in semester system: A case study of Tribhuvan University, Nepal	Article		2023	Fourth and corresponding author	Area of interest
31	Integrating Collaborative ICT Tools in Higher Education for Teaching and Learning: A Modest Proposal for Innovation in Digital Instructions	Book Chapter	Scopus	2023	Single Author	PhD issue
32	Development and Evaluation of E-Learning Courses: Validity, Practicality, and Effectiveness	Article	Scopus Q2	2023	First and corresponding author	Area of interest
33	Ensuring Higher Learning Outcomes through E-	Conference proceeding	Scopus	2023	First and corresponding author	Area of interest

	learning: An Example of Kathmandu University School of Education, Nepal					
34	Students' Experience in Learning Trigonometry in High School Mathematics: A Phenomenological Study	Article	Scopus Q4	2023	Third and corresponding author	Area of interest
35	Virtual Teacher Professional Development in Nepal During COVID-19	Conference proceeding	Scopus	2023	Third author	Area of interest
36	Extra-curricular activities in secondary schools of Nepal: A survey study	Article		2023	Second and corresponding author	Area of interest
37	Transformation Through Participatory Action Research in a Community School of Nepal	Book Chapter	Scopus	2023	Second author	Area of interest
38	Transformative praxis as a mode of fostering	Book Chapter	Scopus	2023	First and corresponding author	PhD issue

	action learning					
39	Digital Citizenship and Digital Ethics: An Educator's Perspective	Book Chapter	Scopus	2023	Single Author	Area of interest
40	Workshop Activity as a Tool for Enhancing Students' Self- and Peer-Assessment Skills in High School Mathematics	Article		2023	First and corresponding author	Area of interest
41	Mediating effects of employees' education on service quality and customer satisfaction: A study of resorts in Nepal	Article	Scopus Q2	2023	fifth and corresponding author	Area of interest
42	Identity Transformation through Transformative Learning: Nepali Mathematics Educators' Perspectives	Article		2023	Third author	Area of interest
43	Experiencing Transformative	Article	Scopus Q1 and	2023	Fifth author	Area of interest

	Learning during Participatory Needs Assessment of a Public School: Journeys and Arrivals to Relational Ontology (ies)		Web of Scienc e Q2			
44	Secondary Level Mathematics Teachers' Critical Reflections on the Use of GeoGebra for Teaching Trigonometry	Conference proceeding	Scopus Q4	2023	Second author	Area of interest
45	AI Chatbots as Math Algorithm Problem Solvers: A Critical Evaluation of Its Capabilities and Limitations	Conference proceeding	Scopus Q4	2023	First and corresponding author	PhD issue
46	How can I thank Scott Tunison, Keith D. Walker, and Janet Mola Okeko for presenting over 70 qualitative research concepts? A book	Book review	Web of Science Q2	2023	Single Author	Area of interest

	review of Varieties of Qualitative Research Methods: Selected Contextual Perspectives					
47	How Do Arts Contribute to Educational Research? A Book Review of Arts-Based Research in Education: Foundations for Practice	Book review	Web of Science Q2	2023	Single Author	Area of interest
48	Procedures for online peer assessment: Assessing algorithm problems in school mathematics for future teachers	Article		2023	First and corresponding author	Area of interest
49	Thank You, Tony E. Adams, Stacy Holman Jones, and Carolyn Ellis, for Offering the	Book review	Web of Science Q2	2023	Single Author	Area of interest

	Handbook of Autoethnography					
50	Ensuring quality in qualitative research: A researcher's reflections	Article	Scopus Q1 and Web of Science Q2	2023	Single author	PhD issue of quality standards
51	Collaborative Autoethnography: Emancipatory Research for Educational Researchers	Editorial		2023	First and corresponding author	PhD issue of methodology
52	Developing the Contextualized SERVQUAL Instrument for Measuring the Service Quality of Nepali Resorts: An Application of the Modified Delphi Technique	Article	Scopus Q2 and Web of Science Q2	2023	Third and corresponding author	Area of interest
53	Writing Philosophical Autoethnography: A Review	Book review	Web of Science Q2	2023	Single Author	Aligned to PhD writing styles
54	Implementing Transformative Education with Participatory Action Research:	Book review	Web of Science Q2	2023	Single author	Area of interest

	A Review					
55	Drama-Based Pedagogy: Ways of Engaging in Mathematics Learning	Editorial		2023	Second author	PhD issue of arts-based teaching and learning mathematics
56	Transformative Visions of Qualitative Inquiry: Performative, Philosophical, and Artistic Transformations	Book review	Web of Science Q2	2024	Single author	Aligned to PhD writing styles
57	How Can AI Enhance or Hinder Qualitative Studies? A Critical Appraisal from South Asia, Nepal	Article	Scopus Q1 and Web of Science Q2	2024	Single author	PhD issue of contemporary issue
58	Knowing, Doing and Becoming Reflective Practitioners: A Narrative Inquiry of STEAM Educators	Article	Scopus Q4	2024	Third and corresponding author	Area of interest
59	Reality of e-Learning: Success and Failure of	Article		2024	First and corresponding author	Area of interest

	Learning Management System					
60	Meaningful Engagement of Preschoolers Through Storytelling Pedagogy	Article		2024	Fourth and corresponding author	Area of interest
61	How Do We Craft Autoethnography ? A Modest Review	Book Review	Web of Science Q2	2024	First author	Area of interest
62	Reflections and Revelations in Autoethnography : A Review of Meaningful Journeys of Quest and Identity Transformation	Book Review	Web of Science Q2	2024	First author	Area of interest
63	Drama-based Pedagogy for Preschoolers: A Narrative Inquiry of Nepali Educators	Article	Scopus Q3	2024	Second Author	Area of interest
64	Connecting Trigonometry to Its Geometric Roots: An Introduction to	Conference proceeding	Scopus Q4	2024	First and corresponding author	Area of interest

	Trigonometric Values				
65	Generative AI and AI Tools in English Language Teaching and Learning: An Exploratory Research	Article	2024	Third Author	Area of interest
66	Exploring Capabilities and Limitations of Generative AI Chatbots in Solving Math Algorithm Problems	Conference proceeding	2024	First Author	Area of interest
67	Developing Culturally Contextualized Mathematics: The Journey to Becoming a Transformative Teacher	Article	2024	Third Author	Area of interest
68	Participatory learning: Exploring place-based pedagogy for future	Article	2024	Third and corresponding author	Area of interest

	teachers					
69	Teachers' Narratives on Integrating GeoGebra for Enhancing Conceptual Understanding in Mathematics	Conference proceeding	Scopus Q4	2024	Second author	Area of interest
70	Cultural Collaborative Ways of Knowing, Doing, Valuing and Becoming: A ‘Pandheri Guff’ Inquiry of Nepali Women Scholars	Article	Scopus Q1	2024	Fifth and Corresponding author	Area of interest
71	STEAM Education in Nepal: Status, Opportunities, Challenges and Future Perspectives for Nurturing 21st Century Learners	Article		2024	2nd and Corresponding author	Area of interest

72	Beyond the Schools: How Parental Involvement Affects the Academic Performance of Nepali Public School Students?	Article		2024	3rd author	Area of interest
73	Participant Selection Procedures in Qualitative Research: Experiences and Some Points for Consideration	Article	Scopus Q1	2024	1st and Corresponding author	Area of interest
74	Developing engaging STEAM-geometry activities: Fostering mathematical creativity through the engineering design process using Indonesian cuisine context	Article	Scopus Q2	2025	6th Author	Area of interest

75	Connecting the Dots: Teachers' Reflective Practices for Developing Self-efficacy, Emancipation, and Empowerment	Article	Scopus Q1	2025	3rd and Corresponding author	Area of interest

APPENDIX III

LIST OF NATIONAL AND INTERNATIONAL CONFERENCES ATTENDED

S.N.	Title Presented	Conference	Place	Organized by	Date
1	Poster Presented	National Conference on Mathematical Education in Nepalese Context	Kathmandu, Nepal	Tribhuvan University and Kathmandu University	September 27, 2012
2	Attended	International Symposium and Fair on Mathematics and Research	Lalitpur, Nepal	Kathmandu University and Center for Activity-Based Instruction	Feb. 6 & 7, 2015
3	Attended	GIS User Conference Nepal	Hotel Radisson, Kathmandu, Nepal	ESRI India	April 19, 2017
4	Opportunities and Challenges to Use ICT in Nepalese Mathematics Classrooms	Second National Conference on Mathematics Education	Pokhara, Nepal	Council for Mathematics Education	January 6-8, 2015
5	Attended	National Conference on ICT Pedagogy in Mathematics: Higher Secondary Level	Hattiban, Lalitpur, Nepal	Kathmandu University, School of Education and Fulbright Specialist USA	January 30-31st, 2017
6	Role of ICT in Teaching and Learning Mathematics in Universities	National Conference on History and Recent Trends of Mathematics	Kathmandu, Nepal	Department of Mathematics, Balmeeki Campus, Nepal Sanskrit University (NSU)	June 2-4, 2017
7	ICTs Use in Teaching Mathematics: Implications for	National Conference on ICT Integrated Pedagogy of	Kathmandu, Nepal	UNESCO and KU, School of Education (KUSOED)	July 8, 2017

	Professional Development	Effective and Meaningful Learning			
8	Understanding and Usage of Questioning by Mathematics Teachers: An Innovative Teaching Approaches	Second International Conference on Transformative Education And Education Research & Sustainable Development (TERSD-2018)	Dhulikhel, Nepal	UN and KU, School of Education (KUSOED)	October 6-8, 2018
9	Integration of GeoGebra in Teaching Mathematics: Insights from Teaching Experiment	7th National Conference on Mathematics and Its Application (Ncma-2019)	Butwal, Nepal	Nepal Mathematical Society	January 12-15, 2019
10	STEAM Education: An Eye Opening for 21st Century Education	Second International Conference on Applications of Mathematics to Nonlinear Sciences (AMNS-2019)	Pokhara, Nepal	Association of Nepalese Mathematicians in America (ANMA) Nepal Mathematical Society (NMS) Central Department of Mathematics at Tribhuvan University Department of Mathematics at Kathmandu University	June 27-30, 2019
11	Use of GeoGebra for Teaching and Learning Geometry (Circle): Initiation for Quality Education	Second International Conference on Quality Education	Lalitpur, Nepal	Rato Bangla Foundation in collaboration with MoEST	August 24-26, 2019
12	TVET in Higher Education in Nepal:	International Conference on		Kathmandu University School of	

	Opportunities and Challenges	Technical and Vocational Education and Training for Employment, Income, and Job Quality	Dhulikhel, Nepal	Education and ETHzurish, Swiss National Science Foundation	September 11-12, 2019
13	Online Assessment Through Moodle Platform in Higher Education	ICT in Education Conference	Hotel Yellow Pagoda, Kathmandu	Tribhuvan University, Kathmandu University and Oslo Metropolitan University (As part of the NORHED QUANTICT Project)	September 19-21, 2019
14	Attended	Exploring Local Mathematics Practices of Nepalese Community	Mahendra Ratna Campus, Tahachal	Mahendra Ratna Campus, Tahachal	9th November 2019
15	Envisioning A Transformative STEAM-Based Mathematics Education in Nepal: An Auto/Ethnographic Inquiry	17th International Congress of Qualitative Inquiry	Online	USA	2021
16	Understanding and encountering the ethics of self and others in autoethnography: Challenging the extant and exploring possibilities	International Symposium on Autoethnography and Narrative	Online	USA	Jan 3-5, 2022
17	Transformative STEAM Education as a Praxis-Driven Orientation	18th International Congress of Qualitative Inquiry	Online	USA	18-22 May, 2022
18	STEAM Education in the 21st Century: Promoting	6th International Conference on Equity and	Online	Asian Centre for Inclusive Education (ACIE)	May 19-21, 2022

	Educational Equity and Inclusion	Inclusive Education 2022		Dhaka, Bangladesh	
19	STEAM Pedagogy for Educational Transformation in Nepal (Co-presenter)	6th International Conference on Equity and Inclusive Education 2022	Online	Asian Centre for Inclusive Education (ACIE) Dhaka, Bangladesh	May 19-21, 2022
20	STEAM Skills in Mathematics: Examples from the Classrooms	National Conference on Mathematics and Its Applications (NCMA-2022)	Ilam, Nepal	Nepal Mathematical Society	June 11-13, 2022
21	The Nature of Multi-, Inter-, Trans-disciplinary STEAM Education Curriculum in Nepal (Co-presenter)	epiSTEME-9: International Conference to Review Research in Science, Technology, Engineering, and Mathematics Education	Online	Homi Bhabha Centre for Science Education	July 4-8, 2022
22	STEAM Education for School Teachers in Nepal (Co-presenter)	epiSTEME-9: International Conference to Review Research in Science, Technology, Engineering, and Mathematics Education	Online	Homi Bhabha Centre for Science Education	July 4-8, 2022
23	Workshop Activity in Online Courses of Mathematics Education	14th International Congress on Mathematical Education (ICME-14)	Online	Shanghai, China	July 11-18, 2022
24	Autoethnography: Bringing Lives and Research Together	The 3rd International Conference on Transformative Educational Research and	Online	Kathmandu University School of Education, Hattiban, Nepal	Nov 4-6, 2022

		Sustainable Development			
25	Attended	TQR 14th Annual Conference	Online	TQR, USA	February 16-18, 2023
26	Reality of E-Learning: Success and Failure of Learning Management System	The 19th International Scientific Conference eLearning and Software for Education	Online	Bucharest, Romania	April 27-28, 2023
27	Blended Learning Pedagogy: Ensuring Higher Learning Outcomes	The 19th International Scientific Conference eLearning and Software for Education	Online	Bucharest, Romania	April 27-28, 2023
28	Ensuring Higher Learning Outcomes Through E-Learning: An Example of Kathmandu University School of Education, Nepal	17th International Conference on e-Learning and Digital Learning	Online	Porto, Portugal	July 15-17, 2023
29	Virtual Teacher Professional Development in Nepal During Covid-19	17th International Conference on e-Learning and Digital Learning	Online	Porto, Portugal	July 15-17, 2023
30	How was Resilience Developed? Cases of TVET Sectors During COVID-19 Periods	International Conference on Technical and Vocational Education and Training	Kathmandu University, Dhulikhel, Nepal	Kathmandu University School of Education, Nepal	September 15-16, 2023
31	Arogyam, Snasthyam and Samadhanam: Healthy Practices of Nepali Educator	18th International Conference	Geeta Devi Ramprakash Podar, Mumbai, India	KAASH Foundation, Mumbai, India	October 1-2, 2023
32	Secondary Level Mathematics	28th Asian Technology	Nongnooch Pattaya	Mathematics and	Dec 10-13, 2023

	Teachers' Critical Reflections on the Use of GeoGebra for Teaching Trigonometry (Co-presenter)	Conference in Mathematics (ATCM-2023)	Garden & Resort, Pattaya, Thailand	Technology, LLC	
33	AI Chatbots as Math Algorithm Problem Solvers: A Critical Evaluation of Its Capabilities and Limitations	28th Asian Technology Conference in Mathematics (ATCM-2023)	Nongnooch Pattaya Garden & Resort, Pattaya, Thailand	Mathematics and Technology, LLC	Dec 10-13, 2023
34	Exploring Capabilities and Limitations of Generative AI Chatbots in Solving Math Algorithm Problems	The 15th International Congress on Mathematical Education	-	Sydney, Australia	July 7-14, 2024
35	Teachers' Narratives on Integrating GeoGebra for Enhancing Conceptual Understanding in Mathematics (Co-presenter)	29th Asian Technology Conference in Mathematics (ATCM-2024)	Online	Mathematics and Technology, LLC	Dec 8-11, 2024
36	Connecting Trigonometry to Its Geometric Roots: An Introduction to Trigonometric Values	29th Asian Technology Conference in Mathematics (ATCM-2024)	Online	Mathematics and Technology, LLC	Dec 8-11, 2024
37	Connecting non-Academic and Academic Worlds: Journey of STEAM Scholar	16th TQR Annual Conference	Online	Nova Southeastern University, USA	March 27-28, 2025